A Software Tool to Enable Setting up Network and System Configurations

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Summary

The purpose of this project is to design and produce a software tool for use by BAE Systems, a widely known defence company. The tool is to be used by the SAINTT team (Systems Analysis and Integration Technology).

The team need to be able to set their computers up to imitate already existing systems that are used on ships, created by BAE Systems. The reason for this is that the SAINTT equipment is used to test how different systems integrate and communicate with each other, as well as testing certain parts of each system themselves. Each system that the team needs to be able to imitate will be referred to as 'interfaces' from now on.

The team currently use a configuration file which states the various details that must be set up. This configuration file is run upon start up and sets up any ports or IP addresses specified. At the moment, the team have to manually alter this configuration file in order to get the correct details set up. When carrying out my placement with the team, I experienced first hand how irritating and tedious this could be and when I mentioned I needed a project for my final year, it was agreed that a tool that could be used to set the computers up would be very beneficial to the team.

During the project, it is important to receive constant feedback from the Technical Authority that the system I was producing was as they required. It is a great benefit to me that I have previously worked on the team and know the level of the technical skills of the members of the team.

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Contents

1 Chapter 1 - Introduction **1**

1.1 Company 1

1.2 Problem 2

1.3 Solution 2

1.4 Aim 3

1.5 Objectives 3

1.6 Requirements 4

1.7 Extended Req 5

1.8 Deliverables 5

1.9 Relevance to degree 5

1.10 Project Schedule 6

2 Background Research **7**

2.1 Introduction 7

2.2 The Current System Used 7

2.3 Primary Research 8

2.4 Secondary Research 8

2.4.1 IP Addresses and Formats 8

2.4.1.1 Research 8

2.4.1.2 In relation to the Problem 9

2.4.2 Document Markup Languages 9

2.4.2.1 HTML Research 10

2.4.2.2 XML Research 10

2.4.2.3 In relation to the problem . . . 10
2.4.3 Computer Programming Languages . . . 12
2.4.3.1 Java Research . . . 12
2.4.3.2 C++ Research . . . 12
2.4.3.3 In relation to the Problem . . . 12
2.4.4 GUI Design and programming . . . 12
2.4.4.1 Design Research . . . 14
2.4.4.2 Programming Research . . . 14
2.4.4.3 With relation to the problem . . . 15
2.4.5 Schemas and Grammas . . . 15
2.4.5.1 Research . . . 15
2.4.5.2 In relation to the problem . . . 17
2.5 Previous Solutions . . . 17
2.5.1 PuTTy . . . 17

3 Methodology **18**
3.1 Overview . . . 18
3.2 Design . . . 18
3.3 Write up . . . 19
3.4 Testing and Evaluating . . . 20
3.5 Problems . . . 20
3.5.1 Re Designing . . . 20
3.5.2 Enhancing . . . 21
3.5.2.1 User Guide . . . 21

4 Design **22**
4.1 Configuration Files . . . 22
4.2 Schema . . . 23
4.2.1 Initial Design . . . 23
4.3 GUI . . . 26
4.3.1 Navigation . . . 26
4.3.2 Graphics . . . 27

4.3.3 Initial Design . . . 28
4.3.4 Comments . . . 28
4.3.5 Final Design . . . 28

5 Implementation **29**
5.1 GUI . . . 29
5.1.1 Problem I . . . 29
5.1.2 Solution I . . . 30
5.1.3 Problem II . . . 31
5.1.4 Solution II . . . 31
5.1.5 Final GUI . . . 32
5.2 File I/O . . . 32
5.3 Validation . . . 33
5.3.1 Node Id . . . 33
5.3.2 IP Addresses . . . 34
5.3.3 Network Card . . . 34
5.3.4 Port numbers . . . 35
5.4 Global Data . . . 36
5.5 IP Aliasing . . . 36

6 Testing **38**
6.1 Phase I . . . 38
6.2 Problems and Alterations . . . 38
6.3 Phase II . . . 39
6.4 Problems and Alterations II . . . 39
6.5 Phase III . . . 39
6.6 Problems and Alterations III . . . 40
6.7 Phase IV - Final Testing . . . 40
6.8 Problems and Alterations IV . . . 40

7 Evaluation **41**
7.1 Evaluation Criteria . . . 41

7.1.1 User Requirements . . . 41
7.1.2 Aim & Objectives . . . 43
7.1.3 Minimum Requirements . . . 43
7.1.4 Additional Functionality . . . 45
7.1.5 Methodology . . . 45
7.1.5.1 Design . . . 45
7.1.5.2 Write Up . . . 46
7.1.5.3 Testing and Evaluating . . . 46
7.1.5.4 Problems . . . 46
7.1.6 Usability . . . 47
7.1.7 Additional Functionality . . . 48
7.1.8 Testing . . . 49
7.1.9 Company Evaluation . . . 49
7.1.10 Improvements . . . 49
7.1.11 Comparison of Other Products . . . 50

Appendix A: User Reflection **51**

Appendix B: Tasking Memo **53**

Appendix C: Gantt Charts **57**

Appendix D: Past Configuration File **60**

Appendix E: Tutorial Notes **61**

Appendix F: New Configuration File **63**

Appendix G: Schema Design **68**

Appendix H: GUI Design **76**

Appendix I: Final GUI Design **81**

Appendix J: Glade Windows **84**

Appendix K: GUI Problems **87**

Appendix L: Screen Shots of Program **94**

Appendix M: Phase I Test Schedule **102**

Appendix N: Phase II Test Schedule **105**

Appendix O: Phase III Test Schedule **109**

Appendix P: GUI Feedback **116**

Appendix Q: User Guide **118**

Appendix R: GUI Design Research **130**

Appendix S: Creating a DTD **141**

Appendix S: Company Evaluation **143**

Appendix U: Details of Additional Functionality **145**

Bibliography **147**

Chapter 1

Chapter 1 - Introduction

1.1 The Company

BAE Systems is the largest European defence company that assists in the development, delivery and support of advanced defence systems. They produce software for systems in the air, on land, at sea as well as in space. The company also design, manufacture and support military aircraft, ships, submarines, radar, guided weapon systems and much more. They provide major operations accross five continents and to customers in over 130 coutries. They have a subsidary in the US which is based in Rockville, Maryland. This company is responsible for developing the transatlantic business, relationships with the US Government and managing its US based Operating Groups which collectively employ over 45,000 employees in the US, UK, Sweden, Isreael and South Africa.

More specifically, the SAINTT (Systems Analysis and Integration Technology) team are a small team within BAE Systems who provide a set of programs to enable the testing of existing systems and aid the production and development of new systems. SAINTT is used to create and run 'scenarios' to imitate various real life activities such as firing missiles and detecting foreign vehicles. In order to run these scenarios and test that the existing systems are behaving correctly, the computer must be set up to imitate that system. This is where this project comes into play.

1.2 The Problem

The problem the SAINTT team have is that there is no software to enable the setting up of the computers. This means that currently, when members of other teams wish to use the SAINTT system, a member of the SAINTT team must be called to set the machine up for them. As can be imagined, this is very tedious and time consuming. The main aim of the SAINTT equipment is to imitate other existing systems created by the company. This means that it has to behave exactly like the real system would without the physical actions. For example, if it were imitating a weapons system, it would produce the exact same signals and outputs as the weapons system, but when the 'fire' signal is emmited, it won't actually fire a weapon. But in order to assure accurate testing, everything the weapons system does within the computer needs to be replicated by the SAINTT machine. It was decided that some kind of tool was needed so that all members of BAE Systems could set their computer up to imitate any other system when needed, without the aid of a SAINTT team member.

This involves enabling specific numbers of IP Addresses and Ports to be set up along with various other attributes specific to each interface (system). The tool must produce a configuration file when the user exits which will then be run on reboot to actually set up the physical IP Addresses and Ports specified. It is also required that the tool automatically displays the current configuration to the user on starting the tool and that there is an option to save the configuration to a specified name for future use. This will prevent users having to repeat the set up for long/complex configurations or just commonly used configurations. It will also help when the team have to perform tests to prospective clients so that they can simply load previously saved configurations rather than spend time setting the machines up at the time.

BAE Systems provided a 'Tasking Memo' outlining the problem and certain guides towards the solution. This document can be seen in Appendix B.

1.3 Solving the Problem

The SAINTT team agree that the current procedure for setting up the required details of the machines can be greatly improved and efficiency will be increased through the use of a software tool. The above problem will be solved by producing such a tool with a user friendly graphical interface that will be simple to use. The loading and saving of configurations will greatly improve the usability of the SAINTT system and give the system a better overall appearance to prospective clients. It will benefit the whole

company since it will enable any team member to set up their own machine and will prevent mistakes being made which could lead to inaccurate test results. When producing the software to solve this problem, the current structure of configuration files will be taken into account and the views of the current SAINTT team will be used to assist the production of the tool. It should be noted that for each interface, more than one set of IP Addresses can be set up. In order to distinguish between these sets of IP Addresses, they are allocated a 'node Id'. Each set of IP Addresses and node Id on each interface will be refered to as a 'node' from now on. Since the company run on 'secret' networks that are not allowed access to the internet, a web-based tool would not be of benefit.

1.4 Aim

The aim of this project is to produce a stand alone tool that can be used to configure computers to imitate existing systems at BAE Systems. The tool should allow the user to set up IP Addresses and Sockets for the various interfaces supported by the SAINTT team. The interfaces refered to here are interfaces (or systems) created by BAE Systems that are specific to the company. The tool will be used to set up computers to imitate one of fifteen different interfaces (although the scope of this project is to get the tool to work for five different interfaces). Each interface implemented has a different specification and various details must be set up. It has been asked that the tool should be able to load previously saved configurations and save the current configuration for future use. This feature is required so that common configurations do not need to be set up again and again since some configurations will have many interfaces set up at one time.

1.5 Objectives

To enable the aim to be completely satisfied, the following objectives must be met:

- Design and produce a GUI for the tool
- Enable the tool to read in previously saved configurations
- Enable the tool to write out configurations that are to be saved
- Ensure validation of all information entered by the user
- Design and produce a schema to ensure validation on input and output configuration files

- Fully test the tool before delivering to BAE Systems for feedback
- Take any points brought up by the company and amend the tool as applicable

1.6 Minimum Requirements

In order to achieve the aims of this project, the following minimum requirements must be met:

1. View and Edit configuration Files.
    - The tool should be able to view the current configuration and allow the user to edit any details as they may wish. The user should be able to chose whether they want to save over the original configuration or save it to a new name.
2. Manage and Load previously saved conifurations.
    - The tool should allow the user to open/load previously saved configuration files and then update the file that is used to produce the physical IP Addresses and Ports so that the current configuration is set up on reboot.
3. Enforce correct syntax of input and output configuration files
    - The tool should automatically check that the files being read in and written out comply to a previously written schema. If the input file has incorrect syntax, the tool should alert the user of the error. If this error is produced on start up, default values should be used. If this error occurs on loading another configuration, the current configuration should remain..
4. Validate user input
    - The tool should check every field that the user inputs and validate it against a previously agreed set of values for the specified field. If the user enters an invalid piece of information, the tool should alert the user and allow them to re enter the information. Invalid information will never be saved to a configuration file.

Any other features added to the software will be an aditional benefit to the tool, not specifically required by BAE Systems but of benefit to them.

1.7 Possible extension of minimum requirements

If any of the following are met, the overall system will be of greater use to the company:

1. Function to allow easy addition of new interfaces

    - An additional function could be added to the tool to allow a SAINTT team user to add new interfaces to the tool. This function must only be allowed to be used by a SAINTT team member and so should be password protected. After adding new interfaces to the tool, the team member will have to deliver the new tool to those who may need it. The additonal feature would produce the required additional menu items and GUI screens and produce the code for the correct configuring of the interface. This feature would be very beneficial to the team but would also be quite complex. The main reason being that it would be very difficult to devise a generic form of interface specification that would be appropriate to any possible interface.

2. Manual

    - If there is time, a manual should be provided to the team so that they can forward it to any member of the company who currently use the SAINTT system. It could also be beneficial to the SAINTT team members themselves in case they are ever called out to support a problem with the new tool

1.8 Deliverables

There will be one deliverable for this project, possibly two if extended requirements are carried out. The main deliverable will be the software tool itself which should be delivered on CD. The possible additional deliverable would be a user manual, which should be in website format for use on the company's intranet.

1.9 Relevance to degree

This project will require many skills learnt thoughout the past four years. The main skills required are programming (SE10, SE20, SE24 and experience from work placement), knowledge management

(DB32) and human computer interaction (GI11). It is clear that many other skills will also be required which will be learnt along the way.

1.10 Project Schedule

In project management, it is very important to have a schedule to follow to ensure the project is completed correctly and on time. There are many ways of producing a schedule, Gantt Charts being a widely known and used way. This way of scheduling enables you to keep track of your plan as well as your actual work load, so that you can make any adaptations needed if it becomes clear you are widely behind schedule. An initial Gantt Chart was created for this project but along the way it became clear that some alterations were needed. Certain sections were no longer needed and additional sections had to be added. All versions of the Gantt Chart can be located in Appendix C.

Chapter 2

Background Research

2.1 Introduction

This chapter will look into the current 'system' used at BAE Systems. It will also explore many different aspects required to create the new system, looking at advantages and disadvantages where appropriate and explaining how each aspect can be used in the new system.

2.2 The Current System Used

Currently BAE Systems do not use a specific computerised system to set up their computers. Instead, they use a configuration file which is edited when new configurations are required. The file contains all the information required by the computer so that, on start up, the correct IP Addresses and Ports are set up. A sample configuration file currently in use can be seen in Appendix D.
It is quite clear that this approach is very inefficient and quite a 'hacky' way to set up the computers. The current system means that it is quite easy, and possible, to incorrectly set up the computer and it also means that setting up is very tedious. The new system will need to take into account the current values stored in the configuration files and use the same approach to set up the actual IP Addresses and Ports (ie on start up).

2.3 Primary Research

Since I carried out a years placement at BAE Systems on the SAINTT team, I have first hand experience of how the current system works and how the configuration files must be altered in order to set up different interfaces (systems). I will take my years experience into account when producing the solution and I will ensure constant feedback from the current team members throught the production of the solution.

2.4 Secondary Research

In order to produce an accurate solution, I first need to do some research

2.4.1 IP Addresses and Formats

The system produced to solve the problem will need to validate information entered by the user to set up configurations for the computers. One of the pieces of information needed from the user will be an IP Address. The following section explores the format of IP Addresses to gain the required knowledge to validate the user input.

2.4.1.1 Research

In researching IP Addresses and their formats, it was realised that there are more than one type of IP Address. In fact there are many different classes of address that can be used for different things.
[1] explains the basics of the format of an IP Address, sumarised as follows:

- An IP Address must consist of four numbers
- Each of these numbers must be between 0 and 255
- No IP Address can consist totally of 0s or 255s
- Each number is seperated with a '.'

For example, 123.45.67.89
When it came to looking into the various classes of IP Address, it became apparent that there are five different classes in total; Class A, Class B, Class C, Class D and Class E. [2, 3] explain these classes in

Class	Use	Restrictions
A	Assigning addresses to clients	The first term in the address must be between 0 and 126
B	Assigning addresses to clients	The first term in the address must be between 128 and 191
C	Assigning addresses to clients	The first term in the address must be between 192 and 223
D	Reserved for multicast addressing	The first term in the address must be between 224 and 247
E	Reserved for future development	The first term in the address must be between 248 and 255

Table 2.1: Different IP Address Classes

more detail. Table 2.1 was constucted by combining summaries of both books. It was also noted that the networking number 127 is reserved for the 'local loopback' which is used for trouble shooting. Each class has a subnet mask assignment which follows the same format as an IP Address but is used to define which parts of the IP Address refer to the network address and which refer to the node address. There are default subnet masks associated to classes A–C which are 255.0.0, 255.255.0.0 and 255.255.255.0 respectively.

2.4.1.2 In relation to the Problem

With regards to the problem in hand and after speaking with the Product Manager, it was agreed that the IP Addresses in the system produced will simply comply to the basic rules stated above along with the rule that the third term of the address must be the node Id (this is a unique number that enables the identification of each node on each interface). Since the final system will be used by BAE Systems, the actual IP Addresses that will be used are secret and so that part of the system will need altering by the company themselves. Due to this, it was decided that no extra time should be put into validating the IP Addresses to comply with any of the four classes and a simple validation should be used.

2.4.2 Document Markup Languages

The input and output files used for the system to load and save configurations will be written in a document markup language. This next section explores the most common markup languages.

2.4.2.1 HTML Research

When looking into which markup language to use for the input and output files, [4] proved to be very useful. After reading over what [4] had to say about HTML, it became clear very quickly that there were more disadvantages to the markup language than advantages. For example, it was learnt that not all computer programming languages are able to read in and write out HTML, making it quite obvious that this markup isn't best suited for the input and output of files in the system being produced. It was also learnt that HTML is hard to read for a human due to the tags being nested and overlapped and, for the same reason, HTML can be complex to write since the writer needs to know all the tags and what they all mean. The final point that helped in a decision being made was that HTML is hard to debug - the omission of a simple tag can takes ages to resolve.

2.4.2.2 XML Research

XML is another markup language that was based on HTML. [5] discusses the advantages and disadvantages of using XML and goes into detail on what XML is. As a summary, we learn that XML is a **metamarkup** language that is used for text documents. A metamarkup language is one that does not have fixed tags and elements that have to be used - the user can specify the names of both. The data entered is written as a string and is surrounded in tags, a bit like HTML.
Table 2.2 summarises the advantages and disadvantages of using XML, obtained from [5, 6]: As can be seen, there are a lot more advantages than disadvantages.
When it comes to parsing XML using most languages, there are two different API's that can be used; SAX and DOM. There is also data binding which is used with regards to Java.

2.4.2.3 In relation to the problem

After taking into account the above findings, it is obvious that XML should be used in relation to the problem. Since the system is going to need to read in and write out files as well as validate information, XML seems to be the best option as it can do this all in one. Since it has not been decided what programming language is going to be used, it is probably best to look into using DOM or SAX APIs when parsing XML into the program.

Advantages	Disadvantages
Metamarkup language. This allows the developers and writers to define their own elements as they need them. It means that descriptive names can be used for tags which is good practice.	It uses basic parsing requirements which doesn't support a wide range of data types
It provides a grammar for the document. This specifies where tags are allowed to be placed, what they must look like, what names are legal ...	XML is not very concise
You can use a parser that is able to read any document in most programming languages	Parsing can be hard to grasp
The language is well structured and can be easily read by humans	There are some bad parsers around
It is clear to the reader what data belongs to what information	
Validation can be carried out using a schema	
It provides a good format for text documents which is useful for reading in and writing out files	
XML is easy to debug - a basic text editor can be used	
It is language and platform independent	
[5] says, > If a Perl program and a Java program need to communicate, generating and processing XML can be simpler than the alternatives.	

Table 2.2: Advantages and Disadvantages of using XML

2.4.3 Computer Programming Languages

When deciding what programming language to use for the product that is to be created to solve the problem, it seemed a good idea to look into those languages that a basic knowledge of is already known. So, both Java and C++ were researched.

2.4.3.1 Java Research

Table 2.3 shows the advantages and disadvantages of using Java which has been collated by summarising information obtained from [7, 8]

2.4.3.2 C++ Research

[8] was also used to look into the advantages and disadvantages of C++ as shown in Table 2.4 [8] also states:

> C++ is an object-oriented language, and when you program well in C++, you are thinking about objects and their responsibilities. Tiny programs in C++ look very much like programs in C, but larger C++ programs are completely different.

2.4.3.3 In relation to the Problem

Looking at the advantages and disadvantages of C++ and Java above, along with the fact that the most recent language I have used is C++, it has been concluded that C++ should be used to code the system to solve the problem. It appears C++ has more resources and help with regards to parsing XML and I have had previous experience parsing with this language. When discussing this conclusion with the Product Manager, it was agreed that this was a good choice, especially since the Software Engineers at BAE Systems only know C++ and not Java and they will be required to keep the system up to date in the future.

2.4.4 GUI Design and programming

Since one of the important factors of the solution is that the system is easy to use and must have a pleasant graphical interface, it is important to look into how to design such a system and, more importantly, how to program it.

Advantages	Disadvantages
Supported by almost all operating systems and web browsers	Some esoteric things can be hard to do - although it could be argued that this is true for all languages.
Java allows high security	The resulting code seems to be slower than C++
It is easy to create network based applications using client/server	The editors aren't that good
Classes are stored in seperate files.They are only loaded into the interpreter when needed	The debuggers aren't as well written or as robust
Java can automatically clean up lost memory although this may slow things down	Java is still new - it isn't as mature as other languages
It is much simpler to write than most language and it provides *nearly* all the flexibility and power of C++	

Table 2.3: Advantages and Disadvantages of Java

Advantages	Disadvantages
The resulting program can be run on all platforms (although the code must be recompiled on each platform)	A relatively complex language (I already know how to code in C+ + so this doesn't really relate to me)
It has advanced features - memory can be examined and adjusted directly	Subtle bugs can be implemented very easily which can lead to memory 'leaks'
Programs run quickly and take up little space in memory	It doesn't support automatic clean up of lost memory
There are many ways to obtain the same result	Memory can be overwritten
Programs created are easier to obtain and are more reliable	

Table 2.4: Advantages and Disadvantages of C++

2.4.4.1 Design Research

When it comes to designing a GUI, there is a lot to take into consideration. A summary of things to remember and things to avoid can be seen in Appendix R. When creating the GUI for my program, I will ensure I adhere to as many of these rules as possible and try to maximise the usability of the GUI. Some key points I will remember are to ensure the layout of all windows is the same and, if not identical, then very similar, not to over complicate the program by trying to help the user, use icons where appropriate but don't confuse the user by using icons relating to another function. When designing the GUI, it is important to think about the different types of people who are going to be using the program; their age, their ability, their competance etc. It is important to design a GUI that appeals to all the prospective users. In order to ensure the GUI is appropriate, designs will be discussed with the Technical Authority Manager of SAINTT and amendments will be made where necessary.

2.4.4.2 Programming Research

After researching programming a GUI, it appears that there are a few different ways that it can be done. Firstly, there is a program on linux that can be used to create the GUI. This program is called Glade and works by creating an XML file which contains all the details of the GUI. In this program, you can create every window and dialog needed and using the properties menu you are able to name every 'widget' for use in the code later. It is also possible to add all signal handlers to buttons, menu items etc using Glade and name them as required for later use. To use the GUI created with this program, the Glade library must be linked into the makefile when creating the program from the code. Within the code, a call must be made to open the XML file created by Glade followed by a call to automatically connect the signal handlers to the 'widgets'. However, as far as can be seen, Glade is only compatible with C++, not Java. Since earlier on in my research I decided it would be best to use C++ over Java, Glade is an option I could use.

Another option is to use the GTK library and create the GUI within my code by hand. This could be quite time consuming but is another option. In this case, all signals would be connected to widgets when needed. If this option was to be used, it would be a good idea to have a seperate class that creates a basic window and one that creates a basic dialog. These classes could then be used everytime a new window/dialog was to be created and by providing certain methods, the required changes could be made when necessary.

Finally, there is a library called gtkmm that could be used. This library provides a basic generation of every widget provided by GTK and would be used in my code by inheritance. This option seems to be a better way of creating the GUI than the hard coding using GTK, since a lot of the code is already done for you within the library. It would be a lot quicker and simpler than coding from scratch.

2.4.4.3 With relation to the problem

Many of the design aspects mentioned above are for larger, more complex systems than the one being produced. Those that are relevant to this solution will be taken into account when producing an initial GUI design. More importantly, the design will be presented to the Technical Authority Manager of SAINTT and the feedback will be used to create the final design before any programming is carried out. It appears that Glade works well with C++ and provides a simple and easy way of producing the GUI. This will be the approach used for the solution. [11, 12] will be used to help with using Glade.

2.4.5 Schemas and Grammas

Since I am using XML for my configuration files, it would be a good idea to look into using a schema or grammar with the file to ensure correctness of the file. This would ensure that all files being read in are of the correct format and contain all the right tags in the correct order for the program.

2.4.5.1 Research

After reading a few books on XML Schemas, it appears that there is more than one type of schema to chose from. The following information was obtained by sumarising the content from [13] and [14].
DTD's
Standing for 'Document Type Definitions', DTDs provide a source of tools for defining the element and attribute structures allowed in a document. It can also be used as a way to provide default values for attributes and for defining metadata information. They are widely supported and used although the capabilities provided have quickly been outgrown.
Some disadvantages of DTD's are:

- They don't support namespaces
- They have weak data typing
- They are easy to learn how to use but the readability isn't that great

- You can't define a root element

This last point means that it could be possible for a file to be 'valid' even if it is missing the first 4 elements, say, but has the rest of the elements correct.

On the other hand, DTD's have the widest support in literature and software and have 10 data types available.

A DTD:

Declares a set of allowed elements - no other element name can be used other than those specified in this set.

Defines a 'content model' for each element - the content model is a pattern that specifies which elements or data can go inside an element. It also specifies the order the elements/data must be in, how many of each element/data can be entered and whether the element/data is required or optional.

Declares a set of allowed attributes for each element - the attribute declaration defines the name, datatype, any default values and the behaviour of the attribute. (The behaviour would be something like if the attribute is required or optional)

Provides a variety of mechanisms to make the model easier to manage. e.g, parameter entities and the ability to import pieces of the model from external files.

W3C

W3C Schemas define shared markup vocabularies and allow machines to carry out rules made by people. They provide a means for defining the structure, content and semantics of XML documents. It is a simpler schema to use since it is expressed in XML and is easy to read. The structures and datatypes are more similar to those of programming languages and a great benefit of this schema is that it has over 40 datatypes and the author can define their own custom types. Another benefit is that it offers object oriented features like polymorphism.

Relax NG

This is a relatively new type of schema and there's not that much information available. From the little information obtained, it is clear that this schema is simple to use and provides schemas that are simple to read and write. It is possible to convert Relax NG schemas into other schema langages such as those mentioned above.

All schemas should begin with a text declaration. This looks like an XML declaration but it explicitly excludes the standalone property. In this text declaration, you can specify character sets other than

the default and you can change the XML version number. Schemas must not contain a document type declaration.
It is possible to get software programs that create schemas for you, or at least aid you in the creation of them.

2.4.5.2 In relation to the problem

Having looked around for a program to aid the production of an XML schema, I have decided on using Altova XML Spy 2007 Enterprise. This program helps with the creation of W3C XML Schemas so this is the XML schema I have decided to use. The program provides an online tutorial which I will complete, making notes along the way. The notes created while performing the Altova tutorial can be seen in Appendix E

2.5 Previous Solutions

Although there are no computer systems available specific to this problem, there are other types of systems available that carry out some of the functions required by this solution. These will be looked at with the hope that they provide relevant help towards producing a solution.

2.5.1 PuTTy

PuTTy is a program used to connect to another computer. You can use it to connect to a Linux machine from a windows machine or simply between two machines. You need to know the IP Address of the computer you are connecting to as well as some other information. This program isn't really very helpful to me since it doesn't actually set up IP Addresses on the current machine which is what I am wanting to do. Also, to solve the problem in hand, there are many more constraints and certain sections of information that need to be obtained from the user depending on the 'interface' (system) being set up. The solution required is far too specific to the company for any pre existing software to be of use.

Other than PuTTy, there don't appear to be any other programs that may be of any use. It appears that there is no software available to set up IP Addresses on a linux machine, there are only guides explaining how to do it manually.

Chapter 3

Methodology

3.1 Overview

In order to decide on a design methodology for my project, I decided to look up some existing methodologies and use this information to create my own methodology, specific to my project. The existing methodologies I researched were the Waterfall model, Iterative model and Spiral model, gaining information from [15]. I decided it was best to split the methodology up into sections for the design, write up, evaluation and what I will do should any problems occur.

3.2 Design

When it comes to deciding on a methodology for the design of my software, it is important to decide on the various stages before deciding on how to apply each stage in a methodological fashion.
The different stages required to complete the software are; design the GUI, design a schema, code GUI, code input and output, code validation of data, code creating physical IP Addresses.
I think the best design methodology for the design is a combination of all three existing methodologies listed above. Through previous experience of coding, it is inevitable that problems/errors will occur where they are least expected and therefore the methodolody used needs to allow for this.

There are two stages in the design that will require feedback from BAE Systems, these are the design of the GUI and schema. Therefore, it is obvious that these two stages will follow a more sequential methodology where an initial design is created, it is passed to the company for feedback and then the design is updated in accordance to these views. This could cycle around many times until both the Technical Authority Manager and I are happy with the final outcome.

Coding the software will also follow quite a sequential approach but will have a lot more 'loops' within it to allow for amendments. It is not a reasonable design to say that the whole of the GUI coding will be done and then that section will be complete, it is obvious to me that this section will be reached again throughout the rest of the coding. For example, there may be a new window/dialog that is needed that I hadn't initially thought of. If this is the case, wherever I am in the coding methodology, I will have to loop back to the GUI coding section before continuing where I was. The rest of the coding should follow the same kind of methodology as the coding of the GUI. Again, there will probably be times when I have to loop back to a previous section before I can continue, but this is what I expect.

To help keep myself on track, I feel it is important to create some milestones along the way. I think the most important ones with the coding are completing the GUI and completing the main coding (ie not the coding of creating the physical IP Addresses). These milestones can be seen in the Gantt Charts in Appendix C.

3.3 Write up

The design of the methodology for writing up my report won't really follow any specific existing methodology. I think it is best to write up my report as I go along, so to speak. That is to say that I won't simply complete the software and then begin with the write up. This would be a stupid design since there will be many aspects I will have forgotten about along the way. I feel it is much more efficient to keep the report going, a bit like an ongoing diary of events which is filled in as and when certain things happen. This 'diary' can then be touched up nearer the completion of the software to ensure it is correct and all the correct sections have been written about. I think this is a good idea as it will ensure I don't miss any problems or thoughts during the coding while at the same time it won't take all my time away from producing the software itself.

A milestone for the mid project report will be created as well as a milestone for completing the write up. These can both be seen in the Gantt charts in Appendix C.

3.4 Testing and Evaluating

Once the software is complete, it is necessary to test it. This will be done by following a 'test sheet' which I will create. This ensures that I remember to test everything and the results will be monitored. During this testing phase, I will also evaluate the software, commenting on the results of the test. This will be a very sequential process, taking one step of the test at a time and evaluating in the same way. Once I have completed the testing, it may (probably) be necesarry to make amendments to the software. Once this is complete, I will repeat the test sheet and record the results as before. This may be repeated many times before I am satisfied with the software. At this point, I will pass the program over to the Technical Authority Manager at BAE Systems, who will then test the software himself and provide me with some kind of an evaluation. If there are amendments needed here, they will be completed and again, this section will be repeated as many times as required.

Since the last part of the testing and evaluation is down to BAE Systems, I need to ensure there is enough time for them to get back to me before my report is due. Therefore, I will create a milestone to ensure I have enough time. This can be seen on the Gantt Charts in Appendix C.

It is also a good idea to constantly test my software while I am developing it, as it would be unrealistic to think I can code the whole software without making mistakes. After each section of coding is done, I will have to compile it and run it to check the correct events happen. This will all be taken into account when evaluating my project.

3.5 Problems

As stated before, it is inevitable that there will be problems along the way with my project. Therefore, I think it will be beneficial to make some kind of a plan as to what to do when/if the time arises.

3.5.1 Re Designing

It may occur that I need to re design my plan for the project if such a problem arises that can't be fixed for some reason. In this case, I will take a step back and look at the Gantt Chart to date and re design the schedule for the future, taking the problem into account. When initially creating my schedule for the project, I allowed myself a lot of extra time just incase an unforeseen problem came up and I needed time to fix it.

The problem may be so great that a whole new plan needs to be created and a different approach taken.

If this is the case, I will have to discuss my new plan with the Technical Authority of SAINTT and agree on any changes to be made. This will severely delay my project so I am hoping it won't be the case!

3.5.2 Enhancing

Assuming no problems are found and that the project runs smoothly, I am hoping to add in some enhancements to the program. Since I don't know if I am going to be able to include any enhancements, I don't think it is wise to use up my time planning the methodology behind creating the enhancement until I know if I have time or not. This is because I think it is inefficient to use up my time creating the methodology just for it not to be used, minimising the time I have to complete the project anyway.
It would depend on which enhancement I chose to include as to how I would create the methodology anyway and the enhancement included would depend on how much time I have. I think the User Guide will be a lot less time consuming so if it looks as though I have a small amount of extra time near the end of the project, I will aim to get this done. On the other hand, if it appears that I have a lot of spare time, I will endeavour to get the 'new interface' enhancement completed. In either case, I will decide on the methodology at the time, although I am sure it will closely follow one of those described above.

3.5.2.1 User Guide

In order to create the user guide, I will follow quite a sequential approach. The user guide needs to be in web format so that BAE Systems can put it on their website. I think the best way to produce the guide is to carry out the main actions while at the same time constructing each section of the guide. Once the main sections are completed, I will go back and carry out the smaller, more minor actions and document these as I go along. Once the guide is complete, I will present it to the Technical Authority of the SAINTT team for their comments.

Chapter 4

Design

4.1 Configuration Files

The first thing to design is the layout of the configuration files that are going to be read in and written out. To do this, it is a good idea to look at the existing format of the configuration file (can be seen in Appendix D) and design the new ones around that.

Since the new files are going to be written in XML, it would be a good idea to first think of the different tags that will be needed. The purpose of the file is to contain the information for various 'interfaces' (systems) as well as some information specific to the current setup but not specific to the interfaces. Therefore, it is an idea to have an 'Interface' tag and an 'Other information' tag.

The next stage in the design of the configuration files is to research what tags are needed within each different interface the software is intended to work for. It may be necessary to ask the Technical Authority Manager of SAINTT for some guidance here.

The final configuration file template can be seen in Appendix F. Of course, it will depend on the configuration that is currently set up as to which interfaces will be in the actual configuration file read in or written out.

4.2 Schema

Now a template has been designed for the configuration files, it makes sense to design a schema to ensure the XML files are in the correct format and contain the correct tags in the correct order (where necessary). I think it is important to send the initial design of the schema to the Technical Authority at the SAINTT team to ensure that no mistakes have been made in my interpretation of the old configuration file. It may be necessary to make amendments to the schema as a result of this.

4.2.1 Initial Design

The initial design will be created using Altova XML Spy 2007. Looking at the configuration file created in Appendix F, it is easy to see the tags that are needed in the schema. What isn't so clear is the rules that go with the tags. After discussing certain issues with the Technical Authority, it became clear that there were certain constraints on each interface the program should work for. The five interfaces that have been requested to be available in the program are called 'DTS', 'Real Coupler', 'SimSaf', 'CSH' and 'LPD'. The reason these five have been requested is that they are all different and most other interfaces the company will need the program to work for are based on these five or are very similar.

One constraint on these interfaces is that the LPD interface can only appear once per configuration. The other four interfaces can appear as many times as the user wishes in each configuration. This means that in the schema, it would be better to have two different tags for the interface, one which allows any number of occurances between 0 and infinity and one which only allows the number of occurances to be 0 or 1.

I think it would be a good idea to create a 'complex type' for each of the five interfaces, these would each specify the format for each interface individually. Each interface follows the same kind of format but there are differences within them:

DTS

The DTS interface needs to contain the following information: Interface Type which will be fixed to 'DTS', Node Id which is a single number ranging from 1-255 (this number is a unique identifier for each interface type in the configuration), socket and extra information. Each tag must exist and must be in the order specified

The socket tag needs to contain the following information: Name which again will be fixed to 'DTS', Local IP Address, Remote IP Address and Port. Again, each tag must exist and must be in the specified

order.

The Port tag needs to contain the following information: Local Heartbeat, Destination Heartbeat, Management, Reliable, Local Unreliable and Destination Unreliable, all of which should contain integers and must exist in the order specified.

Finally, the extra information tag must contain the information for Card which will hold a single number, either 0 or 1 which informs the program of which network card the interface should be configured on.

The DTS Interface can also have an extra option of a 'Snoop' being added to it. This basically means that an interface will be created on both network cards for the given node Id. The specification for this will be detailed in another tag later.

Real Coupler

The Real Coupler interface needs to contain the following information: Interface Type which will be fixed to 'Real Coupler', Node Id which is a single number ranging from 1-255 (this number is a unique identifier for each interface type in the configuration), socket and extra information. Each tag must exist and must be in the order specified.

The socket tag needs to contain the following information: Name which again will be fixed to 'Real Coupler', Local IP Address, Remote IP Address and Port. Again, each tag must exist and must be in the specified order.

The Port tag needs to contain the following information: Local Heartbeat, Destination Heartbeat, Management, Reliable, Local Unreliable and Destination Unreliable, all of which should contain integers and must exist in the order specified.

Finally, the extra information tag must contain the following information: Card which will hold a single number, either 0 or 1 which informs the program of which network card the interface should be configured on, TSM Transmission Method which must hold either 'DTS Mode' or 'VLAN Mode' and ATE Enabled which is a boolean and is optional. Other than the ATE Enabled tag, the other two must be present and in the order specified.

CSH

The CSH interface needs to contain the following information: Interface Type which will be fixed to 'CSH', Node Id which is a single number ranging from 1-255 (this number is a unique identifier for each interface type in the configuration), socket and extra information. Each tag must exist and must be in the order specified.

The socket tag needs to contain the following information: Name which again will be fixed to 'CSH' and Local IP Address. Again, each tag must exist and must be in the specified order.

Finally, the extra information tag must contain the information for Card which will hold a single number, either 0 or 1 which informs the program of which network card the interface should be configured on.

SimSAF

The SimSAF interface needs to contain the following information: Interface Type which will be fixed to 'SimSAF', Node Id which is a single number ranging from 1-255 (this number is a unique identifier for each interface type in the configuration), socket and extra information. Each tag must exist and must be in the order specified.

The socket tag needs to contain the following information: Name which again will be fixed to 'SimSAF', Local IP Address, Remote IP Address and Port. Again, each tag must exist and must be in the specified order.

The Port tag needs to contain the following information: Local and Remote, of which both should contain integers and must exist in the order specified. Finally, the extra information tag must contain the information for Card which will hold a single number, either 0 or 1 which informs the program of which network card the interface should be configured on.

LPD

The LPD interface needs to contain the following information: Interface Type which will be fixed to 'LPD', Node Id which is a single number ranging from 1-255 (this number is a unique identifier for each interface type in the configuration), socket and extra information. Each tag must exist and must be in the order specified.

The socket tag needs to contain the following information: Name which again will be fixed to 'LPD', Local IP Address and Port. Again, each tag must exist and must be in the specified order.

The Port tag needs to contain the following information: Link Port, which must contain an integer and must exist.

Finally, the extra information tag must contain the information for Card which will hold a single number, either 0 or 1 which informs the program of which network card the interface should be configured on.

Snoop

The Snoop tag is an option from the DTS Interface but it is given its own section as if it is an interface

itself. This tag should contain the following information: Interface Type which will be fixed to ‘Snoop’, Node Id which is a single number ranging from 1-255 (this number is a unique identifier for each interface type in the configuration) and Local IP Address.

Throughout all of the interfaces, the Local IP Address and Remote IP Address tags are of type ‘IP Address Type’ which is another ‘complex type’ of the formaterm (which is a number between 0 and 255), seperator (which is fixed to be ‘.’), term, seperator, term, seperator and term. This will ensure the IP Address entered is valid. Validating that the third term is the node Id can’t be done in the XML schema so it must be validated within the code.
So the overall schema must contain an Interface1 tag which can contain as many of the DTS, Real Coupler, CSH, SimSAF and Snoop interfaces, followed by an optional Interface2 tag which can only contain one LPD interface, followed by the following tags which must appear in the specified order: MaxFileSize which is an unsigned short that must be between 100 and 1700, Network Type which is a string that is either ‘eth’ or ‘znb’, Default Template Directory which is a string, Override Template Directory which is a string and Current Setup Directory which is also a string. The Schema used can be seen in Appendix G.

4.3 GUI

The GUI is an important part of the solution, it is important that it is a simple and clear design that is consistent throughout the various windows. The two most important aspects of the GUI are the navigation and the graphics.

4.3.1 Navigation

The navigation between the various windows should be smooth and simple. It is important that the user knows which window or dialog they are on and they shouldn’t be able to access any previously opened windows or dialogs without first closing the current one.
It is a good idea to keep the exit or back menu items in the same place on each window so that the user doesn’t have to search for it. It should be obvious to the user which options involve producing a new window, and new windows should only be used when necessary.
I think it is a good idea to plan when new windows or dialogs should be produced before designing the

whole GUI. It is obvious that the configuration of each interface should produce a new window since this is a seperate entity.

The current setup of the computer needs to be viewable. This will display the currently loaded configuration, current setup files directory, current override templates directory, default templates directory, max file size and network card type. I think this should be displayed in a new window also.

The nodes currently set up should also be viewable in a new window. This would be best displayed in some kind of a table with those nodes configured on card 0 on the left and those configured on card 1 on the right.

If the user wishes to change any of the current setup information, a dialog should appear where the user should specify the new information. The user should be able to save the changes or cancel.

When the user wishes to load a previously saved configuration, the usual select file dialog should be produced. This is the same dialog that will be used when the user wishes to save a configuration.

Within the configure interface windows, it should be possible to view the currently configured ports and also the nodes configured for that interface type. The view of these nodes should be the same as the view of all of the nodes from the main window so as not to confuse the user. The view of the ports should be the same kind of view as the current setup from the main menu.

When the user chooses to add a node to an interface, a popup window should be displayed, showing the various attributes required for the operation. If the user chooses to save the added node, a dialog should appear informing the user that the save was successful. When deleting a specific node, it is wise to produce a dialog where the user specifies the node id of the interface they wish to remove.

If the user wishes to change the IP Address, a new window should be displayed with the current information for the node they are wishing to edit. The user should then be able to edit either of the IP Addresses for that node and then save the node details. Upon selecting 'Save', a dialog should appear informing the user that the save was successful.

If the user wishes to change the port numbers that are configured, a new window should be produced, allowing the user to make the changes they wish. It should then be possible to either reset the ports to what they were originally or to save the new port numbers.

4.3.2 Graphics

Although graphics shouldn't be used too much, it is an idea to use some graphics where possible so that the user knows what the button does without having to read and take in the label. I think it would be a

good idea to use stocks on all buttons possible. Since stocks are used in many programs, they will aid the user remarkably and speed up any process they are carrying out.

4.3.3 Initial Design

The initial design of the GUI can be seen in Appendix H. It was then sent to the Technical Authority Manager of SAINTT and their comments were made.

4.3.4 Comments

The comments made by the SAINTT team can be seen in Appendix P
These comments will be taken into account and a new design will be drawn up and approved by the Technical Authority Manager.

4.3.5 Final Design

The comments made in Appendix P were taken into consideration and my own views used to create a final design. I thought it would be a good idea (if possible) to have a tool bar at the top of any windows, as well as menu bars, which display the most commonly used options as buttons. If available, these buttons will display a stock item for each option.
The final design can be seen in Appendix I. It was approved by the Technical Authority Manager of SAINTT.

Chapter 5

Implementation

This section details the implementation of the solution for my project. It outlines any problems occured and how each problem was fixed or overcome.

5.1 GUI

The first part of the implementation was the GUI. After carrying out background research (section 2.4.4.3), I decided it would be most efficient to use 'glade' to design the GUI. When doing this, I followed the design produced (Appendix I) as closely as possible and at all stages I named each widget and component with self explanatory names for later use within my code.
Creating the GUI within Glade proved to be simple and efficient and it enabled me to get the GUI to look exactly how I wanted it to look. A selection of the windows can be seen in Appendix J.

5.1.1 Problem I

After creating the GUI using Glade, it was time to begin coding and get my program to produce the GUI on startup. Again this seemed to be very simple and, after using Glade tutorials [11, 12] I had the GUI being produced as required.
The next step in the tutorial was to connect the signals for all widgets that required something to happen

when clicked/changed. In order to do this, when creating the GUI, I had to attatch signals to every widget this was needed for. In order to connect the signals, one simple method had to be called in my code. Following the tutorials, this method had to be called after loading in the Glade XML file. After compiling the code, I ran the program but many warnings were produced informing me that it could not find the signal handler for every signal I added to the GUI.

I checked my code thoroughly against the tutorial and used a debugging program called gdb on linux to check what line of code was producing the errors. Sure enough it was when calling the method to connect the signals that all the warnings were appearing. No matter how much I checked my code and looked at the tutorials, I could not see the problem.

I contacted two previous colleagues who worked with Glade while I was working on SAINTT, explaining my problem. They both suggested various things to try but to no avail. I contacted the Technical Authority at SAINTT, telling him of my problem, but no one was able to work out the problem.

Getting desperate, I joined a forum that had a newsgroup for people having problems with Glade [16]. I posted my question but never got a response. I also replied to a thread on the Glade website asking someone who had previously had the same kind of problem if they found a solution and if so, what it was but again got no reply.

Finally, I joined the school of computing newsgroup for C++ but no one replied to my post. I then decided I was getting too far behind schedule to continue like this, it was time to make a decision. Appendix K shows the code I was using and the warnings produced, along with some of the emails I sent and received along the way.

5.1.2 Solution I

I now had two choices. I could either manually connect every signal or I could create the whole GUI from scratch manually (by coding). I thought it would be a good idea to try to manually connect every signal since it would take less time that coding the whole GUI manually and it was possible to test the solution by first connecting just a few signals, minimising the amount of wasted time should this solution fail too.

[17] explained how to do this. So, following the book I began manually connecting some of the signals on the main window. The following method was added to one of my files and called as soon as the Glade XML file had been successfully loaded:

```
//method to connect signals to widgets
void Callbacks::connectSignals(GladeXML *xml)
{
    //obtain widget to connect signal to
    GtkWidget *currentConfigBrowse =
               glade_xml_get_widget(xml,"currentConfigurationBrowseButton");

    //connect signal to button
    gtk_signal_connect(GTK_OBJECT(currentConfigBrowse),"clicked",
                       GTK_SIGNAL_FUNC(
                       on_currentConfigurationBrowseButton_clicked)
                       ,NULL);
}
```

5.1.3 Problem II

This solution didn't get me very far. I had the same problem as before, the signal handlers couldn't be found. This meant that I only had one solution left.

5.1.4 Solution II

I decided rather than coding the whole GUI from scratch, that I would use a library called gtkmm which provides basic code for all types of widgets and GUI components. All you have to do is compile your code with this library and then you can use inheritance to use the pre coded GUI components. This makes it a lot quicker and easier to create the GUI. For example, when producing a window, you inherit from the gtkmm window class and use simple methods to adapt the window to your preferences. For example, set_title('title of window ') allows you to set the title of the window to the title you want.
I used many tutorials and API websites to help me produce my code ([18, 19, 20]). This was quite time consuming but once complete, the GUI worked fine, with no problems.
These problems made me quite behind schedule and it was due to this that I had to re do my Gantt chart to re schedule all the tasks I had left to do.

5.1.5 Final GUI

The initial creation of the GUI was acceptable but not perfect. On the main window and within each configuration window, there is a table that displays the nodes configured on each interface. The initial GUI displayed the correct information but there were spaces between nodes which didn't look that good. I had a look at the gtkmm tutorial [18] and discovered a different widget that allowed you to specify which row and column text was entered to. I realised this would solve my problem but when I tried to use the new widget, I discovered that the version of the gtkmm library I was using was older than the one that had the new widget I wished to use. Therefore, I had to find the source code ([19]) and incorporate it within my code. This proved to be relatively simple since the new widget simply used widgets that I was already using but manipulated them to do other things. This meant that I could just replicate the code within my code and even meant I could personalise the code to be more suited to my program.
Both versions of the GUI can be seen in Appendix L.

5.2 File I/O

After realising that trying to solve my GUI problem may take a while, I decided it would be beneficial to begin coding the file input and output since I didn't really need the GUI to be able to do this. As decided in section 2.4.2.3 I am using XML for my configuration files. In order to read in and write out XML, a libray called xerces is needed. [21] contains an API which proved very useful in coding the file I/O.

In order to write the code to read in the XML file, I needed to closely follow the schema created (Appendix G) since reading in is done as a tree; reading in a node and then moving on to it's child/sibling and reading in that node. It was a very sequential process to read in the XML file and apart from a few 'blips', it went very well.

The main problem I encountered was that there was an extra node after each tag but before the text within the tag. This meant that the first time I tried to read in an XML file, it crashed. This was because I was trying to access certain nodes in a way that wasn't possible for their type. It took a little while to discover what the problem was but once discovered and the relevant alterations made, my program read in an XML file perfectly.

It was important that I remembered that the configuration file being read in could contain many sections detailing each 'interface', eg it is possible to have up to 50 DTS interfaces in one configuration. In order

to allow for this, many loops had to be coded in to ensure I allowed for many of each interface.
As the file was being read in, it was important to store the information required to be displayed since later on it would need to be passed to various other classes in order to display it in the correct places. In order to do this, a simple conversion needed to be made since by default the information obtained from the XML file is in a type specific to xerces. This conversion creates a C++ string which can then be used simply.
After reading in the file, various variables had to be deleted or shut down so as to prevent memory leaks.
When thinking about how the program was going to be used, I decided it would be best to write out a temporary XML file everytime the user pressed the 'save changes' button in the configure interface windows. This is because it was easier to update the main window's display of configured nodes by reading in an XML file.
So, when the user pressed the save changes button, a method would be called in the configure_io file that wrote out the configured nodes to a temporary XML file. This file would then either be deleted or renamed depending on whether the user decided to save their configuration or just quit without saving.
Writing out XML using xerces was also quite simple. Again a conversion was needed to convert the strings into the xerces form of a string and then the reverse method used to retrieve the information was used to write out the information. Before actually writing the information, each tag had to be created and inserted into the XML tree in the correct place. Again, loops were required where there were more than one of the same interface configured.
Once all the tags and information were written to the file, the file was closed and again, certain variables were deleted or correctly shut down to prevent memory leaks.

5.3 Validation

When the user enters information to the program, it is important that it is validated. This is to ensure that incorrect information is not written out to the XML files and that no problems occur later in the program. There are various different validations required.

5.3.1 Node Id

The node Id entered for each configured node must be a number in the range $1 \rightarrow 255$ inclusive. It must also be unique to the nodes configured on each seperate interface. (e.g a DTS node 3 and Coupler

node 3 are allowed but two DTS node 3s are not allowed). So, when the user enters the node Id being configured, it must be checked against all existing nodes on that interface. If it already exists, when the user presses the 'OK' button, they are informed that the node already exists and they are then displayed with the same dialog so that they are able to alter the node Id to something different.

5.3.2 IP Addresses

When the user configures a new node on any interface (node here is referring to the collection of IP Addresses and node Id on each interface), the IP Addresses must be unique. The way the GUI is set up, when adding a new node on a certain interface, the user is prompted to enter the node Id and IP Address(es). When the node Id is entered, if the user presses the return button, the default local IP Address (and Remote IP Address if applicable) is automatically filled in. The user is then able to change this if they wish. When pressing the 'OK' button, the information in the IP Address entry box(es) is obtained and run through a series of checks. First of all I check if it is the default IP Address, since if it is, no further checks are required. If it isn't, I then check that there are 4 terms (4 numbers) and 3 sperators ('.'s). If this test is passed, I then check that the four terms are all numbers in the range 1→255 inclusive. No matter what address the user enters, the third term of the address must be the same as the node Id being configured. Therefore, if all other tests are passed, the next test is that the third term is the same as the node Id entered. Finally, a test is carried out to ensure that no other configured node has the same IP address. If at any point in the validation the test fails, a string is set to hold information of the error that has occured. At the end of the validation, this string is passed back and if there is text stored in it, an error message is brought up explaining the error and the user is shown the 'Add node' GUI they were previously at so that they can fix the problem.

5.3.3 Network Card

The user selects the network card they wish the node to be configured on by using a combo box which contains the options 0 or 1. If when pressing the 'OK' button, one of these numbers hasn't been selected, an error message will be produced informing the user. They will then be displayed the same 'Add Node' dialog so that they can rectify the problem.

5.3.4 Port numbers

The different interfaces that can be configured using the program have various ports that must be specified. It depends on which interface you are configuring as to how many ports and which ports they are. In all interfaces, the ports specific to them must be different to each other. (eg no two ports in the DTS interface can be 6000 but one port in the DTS can be 6000 and one in, say the LPD interface can also be 6000).

Since the port numbers are stored in the XML configuration file that is read in, a check must be made before updating the port numbers within the configure interface windows. If there is an error at all, the default values will be used instead of those entered in the XML file.

It is possible for the user to change these port numbers. When doing so, a check is made every time to ensure the port number is valid. Since it is possible that the user has entered two port numbers round the wrong way, to ensure it is possible to swap them back, I decided it would be a good idea to let the user enter the port number and then prompt them to change the other port number that is the same. So, if the user has the 'management' port set to 6000 and the 'reliable' port set to 6001 but they want them to be the other way around, if they change the management port to be 6001, a message will appear informing the user that they must change the reliable port number and upon acknowledging the message, the reliable port number will be highlighted so that they can simply type the new port number straight away.

These checks are all done by using signals for when the user clicks in or presses enter in an entry box. When the signal is emmited, a method is called which retrieves the information in the specific entry box and then calls all the relevant validation methods required.

On top of this, there is another specification between the port numbers stored in the DTS interface and the Real Coupler interface. Both interfaces have the same ports, with the same names. The way these two interfaces are used by BAE Systems means that certain port numbers in the DTS must be the values of other ports in the Real Coupler interface. Therefore, when either the DTS or Real Coupler ports are changed, the other must also be changed (this will be done automatically). The pairs of ports that must be the same are as follows:

Local Heartbeat & Destination Heartbeat

Management & Reliable

Local Unreliable & Destination Unreliable

5.4 Global Data

It is a good idea when coding a program not to hard code anything. That is, it is not advisable to write something like 'open('/directory/folder/file.extension')' because if this ever changes, it is hard to locate it within the code. Instead, it is a good idea to have a file called 'global_definitions' or somthing similar in which you create a constant variable every time you need to 'hard code' information. These variables are generally written in capital letters so that throughout the code it is clear that the variables are stored within the global definitions file. The variables created within this file will be available to all classes that include the global definitions file. This idea is also more efficient since it prevents duplication of data in some cases. For example, if there is a constant string that is needed in more than one class, rather than create it in each class it is required, it can just be created once in the global definitions file and then the classes that need access to the string can include the file.

5.5 IP Aliasing

The final part of the program is to create the physical IP Addresses on the computer. The way this is done is to edit the scripts that are run on startup so that one of them calls another script which I will create. This script must ensure that the network cards are 'up' and after ensuring this, must then run two scripts that are created by my program. This script needs to contain the following:

```
/sbin/ifconfig eth0 down
/sbin/ifconfig eth1 down
/sbin/ifconfig eth0 up
/sbin/ifconfig eth1 up
/home/saintt/.ip_aliasing0
/home/saintt/.ip_aliasing1
```

Where .ip_aliasing0 and .ip_aliasing1 are the two scrips created by my program.
These two scripts (one for card 0 and one for card 1) contain code to set up the physical IP Addresses. To do this, each script must follow the same kind of format as follows:

```
#Number of aliases: 1
/sbin/ifconfig eth0:0 1.2.1.3
/sbin/ifconfig eth0:0 netmask 255.255.255.0
```

Where the number of aliases is the number of nodes configured on that card. Where it says ‘eth0:0’ this should be the network specified (eth or znb) followed by the card (0 or 1) and the number after the ‘:’ should increment so that if there are two nodes, the second node will be ‘eth0:1’, for example. For every node there should be a line that specifies the IP address and one that specifies the netmask. These scripts must be written when the user saves their configuration. The number of nodes (aliases in this case) was obtained by going through the structure containing all of the nodes and checking which network card they were configured on. Then a for loop was used to write out each node on each card, accessing the IP Address from the structure.

After the user quits the program, a message is produced prompting them to reboot the computer. This is because when they reboot the computer, the scripts are run and the physical addresses are created.

Chapter 6

Testing

Testing is an important part of programming, I feel it is a good idea to test certain things along the way and then, after completion, carry out a test on the whole program to ensure everything works how you expect it to. It is often the case that when new functions are added, they can 'break' other functions that previously worked. Therefore, it is possible that without testing everything once it is all complete, there are errors within the code that you didn't realise.

6.1 Phase I

The test schedule can be seen in Appendix M

6.2 Problems and Alterations

As can be seen from Appendix M, a few errors were encountered. One was pretty major and meant I had to abort the test.

The first error is quite easy to fix. When the user is selecting a file to load, it must be an XML file. There is a filter you can add to the dialog to tell it to only show files of a certain type. At the moment, it is allowing only plain text files to be displayed, this must be changed to allow only xml files.

The second and third errors are similar and can be fixed in the same way. When the file selection dialog appears for two of the browse buttons, the user is supposed to be selecting a folder but the dialog only allows them to select a single file. After researching the File Chooser Dialog, [22] proved to be helpful. Previously, I have been creating the Dialog by passing a string that tells the dialog that its purpose is to open a file. There is a different string that you can use if you want to select a folder instead. So by simply adding a 'bool' to the run method that creates the dialog, I can perform a check and create the dialog in the correct way.
The last error discovered through Phase I testing is caused because when the user saves their configuration to another file, any alterations that are then made and saved aren't saved to the main configuration file. This main configuration file is the file that is automatically opens when the program is started. To fix this problem, when the user presses the save button, the sampleConfigFile.xml file should also be updated.

6.3 Phase II

The test schedule can be seen in Appendix N

6.4 Problems and Alterations II

As can be seen from Appendix N, more errors were encountered. The test was aborted since one of the errors affected the rest of the test.
The first three errors are linked, the problem being that when a file is saved, the values in the entry boxes and combo box aren't saved. This should be a simple fix.
The last error seems to be that the DTS Window is reproducing the node added even though the changes were discarded. This is due to there being an error in the code when the discard changes button is pressed. The code deletes the node that was added but then the next bit of code adds back any nodes that were deleted. To fix this, a check will need to be made so that it only adds back nodes that were actually deleted via the delete buttons.

6.5 Phase III

The test schedule can be seen in Appendix O

6.6 Problems and Alterations III

As can be seen from Appendix O, there were no problems with the test. The only alteration that could be made (but isn't necessary) is to ensure that after loading a previously saved files, when adding a new node, it is entered in the correct row of the DTS Nodes table. This doesn't affect the performance of the program so isn't really required.

6.7 Phase IV - Final Testing

The final testing was performed by the Technical Authority of the SAINTT team.

6.8 Problems and Alterations IV

No problems were found when the program was tested by the Technical Authority Manager of the SAINTT team.

Chapter 7

Evaluation

It is important to evaluate the product thoroughly with respect to both the functionality and the usabilty of the system. The evaluation should be sure to look into detail that the product suits all the requirements made by the company and that at least the minimum requirements are met. As well as this, the impact the system has on the prospective users is also important and should be taken into consideration. Finally, it is important to critically evaluate the system as a whole, detailing any problems or limitations that may have occured.

7.1 Evaluation Criteria

The following evaluation criteria are used to help with the whole evaluation process. They greatly help to make a conclusion as to whether the created system is a success or not.

7.1.1 User Requirements

BAE Systems provided a document (Appendix B) outlining the problem and within the document, certain user requirements can be seen. Table 7.1 shows the User Requirements and whether they were satisfied. Table 7.1 can be backed up by the test steps and results (Appendicies M, N and O), GUI print screens (Appendix L) and the Company evaluation (Appendix T).

Requirement	Degree of Satisfication
The main window should display the default templates and the configured nodes	Fully satisfied
From the main menu the user should be able to edit: Setup files directory, Override Template directory,Maximum file size and Card type.	Fully Satisfied. In order to edit the values, the user has two options; they can manually enter the Value or click the 'browse' button located to the right.
The user should be able to save configurations and load previously saved configurations	Fully satisfied. The file selection dialogs are set up to ensure the correct file type is selected (or folder). The user has the choice to save over the current configuration or save the file to a new name.
The user should have access to the setup for each interface type	Fully Satisfied via the 'Configure Interface' menu item
The interface window should display a more detailed summary of the nodes currently set up on that interface, including the node id, IP Addresses and Port numbers	Fully Satisfied. If no port numbers are in the configuration file, defaults will be displayed
When a node is added, the default IP Address will appear. This can be changed if the user wishes	Fully Satisfied. If the user chooses to change the value, it will be fully validated
The port numbers can be changed	Fully Satisfied. In some cases (for the DTS and Coupler interface) setting the port numbers in one interface automatically sets the port numbers in the other
User input will be validated at all stages	Fully Satisfied. If an entry is invalid, the user will be displayed an error message detailing the problem
Defaults should be used where appropriate. If the user loads an invalid file, the default values for the setup and ports should be used	Fully Satisfied
The program will output a file representing the configuration	Fully Satisfied
The program should read in the current configuration on start up	Fully Satisfied

Table 7.1: Evaluation of User Requirements

On top of the specified User Requirements, it has been verbaly agreed that the program should be reliable and have a good usability (see Section 7.1.6). [23] defines reliable as

> giving the same result on successive trials

When testing the software, the test sheet was run on three successive occasions and, apart from those steps that previously failed, the results were the same on each test. (See appendicies M, N and O).

7.1.2 Aim & Objectives

As can be seen from section 1.5, if the objectives are met, the aim is also met. Table 7.2 shows the Objectives and how well they were satisfied. Although all the objectives were met, it should be noted that there are limitations in relation to more general solutions. Firstly, the specification of each inteface is pre defined within the code so it is not possible to use the program to configure any interfaces other than those already coded. Secondly, it is not possible to define any new interfaces so that the program could be used to configure interfaces other than those already coded since the additional functionality was not completed (see Section 7.1.4).

7.1.3 Minimum Requirements

In addition to meeting the Objectives, it can be said that by completing the minimum requirements that the aim is fulfilled. All of the minimum requirements were met:

View and Edit configuration files - The tool displays the currently loaded configuration on start up. The user is then able to edit/delete any existing nodes and add new nodes to the interface. When saving the file, the user has the option to save over the current file or save the file to a new name. This can be seen from the screen shots of the GUI - Appendix L.

Manage and Load previously saved configurations - The tool lets the user load previously saved configurations. This can be done via the Load button on the tool bar, the File → Load menu item or the first browse button on the main menu. When saving an edited configuration file that the user has loaded, the program updates the current configuration file as well so that on reboot the correct IP Addresses are configured.

Enforce correct syntax of input and output configuration files - A schema is used to enforce the syntax of the XML file being read in as well as those being written out. If the user loads a file that has an incorrect syntax, the user is presented with an error message informing them of this and the program

Objective	Degree of Satisfication
Design and produce a GUI for the tool	Fully Satisfied - see appendicies H and I for design and L for implication
Enable the tool to read in previously saved configurations	Fully Satisfied. Upon reading in the file, the appropriate fields are filled in and displayed
Enable the tool to write out configurations that are to be saved	Fully Satisfied. The current configuration file is automatically updated when saving. If the user saves to a different name, a new ouptup file is created with the desired name
Ensure validation of all information entered by the user	Fully Satisfied. Some of the errors produced can be seen in appendix L
Design and produce a schema to ensure validation on input and output configuration files	Fully Satisfied - see appendix G
Fully test the tool before delivering to BAE Systems for feedback	Fully Satisfied - see appendicies M, N and O
Take any points brought up by the company and amend the tool as applicable	Fully Satisfied - see Appendicies H, I and P

Table 7.2: Evaluation of Objectives

displays the current configuration file. If the syntax error is on loading the current configuration, the program will fill in the required details with default values and leave the rest of the configuration blank.
Validate user input - Every field that the user is allowed to edit or manually input is validated. The validation is carried out against the previously agreed set of values for each field. The user is informed of their error and directed back to the window containing the error so that they can make the necessary changes. No errors are ever written out to a configuration file.

7.1.4 Additional Functionality

The program contains some additional functionality that wasn't planned. For example, there are toolbars on the windows to improve usability as well as tool tips and short cuts.
On top of that, a user guide was created - see Appendix Q.

7.1.5 Methodology

7.1.5.1 Design

As planned, with regard to gaining feedback from BAE Systems, the design of the GUI and schema followed a sequential methodology that (thankfully) only cycled round twice. Both designs had comments made on them which I considered when re designing. In both cases, when producing the new design to BAE Systems, there were no comments made.
Coding the program also followed the planned methodology since I followed a sequential methodology again. As predicted, there were occasions where I had to go back to certain parts of the code to alter either a problem or to alter it due to something I hadn't thought of at the time. For example, instead of coding both the input and output in one go, I coded the input and then went onto the next section of code - updating the GUI. In the initial plan, I had neglected the fact that the GUI would need to be updated, and so I had to go back to the GUI classes and add in the required code. Once this was complete, I continued back to writing the output code.
The inital milestone for completing the GUI wasn't met due to unforseen problems. When creating a new schedule, a new milestone was created. Although I didn't manage to complete the GUI by this milestone either, it was only one week late. The milestone for completing the coding was also one week late. I managed to deliver my product to BAE Systems at the time of the milestone, although it took a week longer than planned to receive their test results and feedback.

7.1.5.2 Write Up

As planned, I wrote up this report as I went along. As soon as I completed one section of the coding, I made a note of how it went etc. After completing the program, I was able to go back to my report and alter what was written to make it more suitable for a report. I followed the same methodology for the testing section of the report to ensure all the results of the tests were recorded accurately and all solutions were written up as I made the necessary alterations to my code. This meant that no information was incorrect or forgotten.

The milestones completed were met, both the mid project report and final report were delivered on time and to schedule.

7.1.5.3 Testing and Evaluating

When testing the program, I followed my planned methodology. I created a test sheet which was filled in on all phases of testing (see appendicies M, N and O). After completing a test (or aborting due to errors) I made the necessary amendments and then repeated the test sheet. I made sure that I tested functions that previously passed the test since it was possible that my amendments had caused unwanted problems in those areas that previously worked. In total, I had to carry out three test sheets before my program passed all steps.

After passing my tests, I passed the program on to the SAINTT Technical Authoroty Manager for him to test and evaluate (see Section 6.7 for information on the test and Appendix T for the evaluation)

Also as planned, I constantly tested my program while producing and updating it. Although it was clear from the test sheets that this testing alone wasn't good enough - there were many small bugs I hadn't picked up along the way.

7.1.5.4 Problems

I encountered a few problems along the way, mainly with the coding of the GUI. As a result of the problems incurred with the GUI, it was necessary for me to create a new schedule. The changes made were required since I incurred a severe delay due to the problems that occured. This entailed pushing back the schedule for the functionality that hadn't yet been coded. Although I did this as planned, looking back, I think it would have been more beneficial to have done this sooner and given up on the original plan for coding the GUI before I did. This would have given me more time to complete the

coding and to have added in the additional functionality. As it happened, I had to change my plan for creating the code for the GUI, twice. Both times, I discussed the change with the Technical Authority and agreed on the new approach. Both version of the Gantt chart can be seen in Appendix C.

7.1.6 Usability

The usability of the program is one of the most important aspects. If the program isn't easy to use or pleasing to the user, it will fail. As can be seen from the background reading (section 2.4.4.1) and Appendix R, I looked into the design of the GUI in great detail before designing and creating it.
The program produced has a good usability, there is a tool bar on all windows that provides the main functions that are most likely to be used. These functions can also be accessed via the menu. I ensured that the design of all windows was the same and that the layout of each was very similar, if not identical. This helps the user since they get used to certain options being in certain places and it would cause confusion if certain things weren't consistent. For example, I ensured that on all dialogs the left button was the cancel or quit button and the right button was the ok or open button. This prevents the user selecting the wrong option by accident after they have used the program many times and got used to the layout.
As can be seen in Appendix L, the initial GUI wasn't as perfect as I would have liked - although it worked correctly, the look it gave to the user wasn't very professional and so I altered how the GUI displayed the configured nodes so that there were no gaps in the tables.
I ensured I used Stocks for the menu and toolbar options where they were available. These are the small picture symbols attatched to the option, like a floppy disk by the save button for example. I feel these add a great benefit and help the user if they are less experienced or new to the program. I also added shortcuts to the menu items where possible so that the user is able to use key commands to call certain menu items. This also adds to the usability as it means that people without a mouse can also use the program. The last addition I made to the tool bar and menu items was that I added in 'tooltips' where possible to give the user more explanation of what the menu/toolbar item will do. This is another benefit for those less experienced and new users.
In order to test if the program has good usablilty, it was passed onto the Technical Authority of the SAINTT team for their view:

> The program seems to have a good flow between the various screens and a simple yet effective display. The addition of tool tips and the tool bar make the program particulaly

> user friendly as they insure that those users with less experience of running the program are lead in the correct direction. When using the program myself, I found it easy to use and I had no difficulty in accomplishing the tasks at hand. Overall I feel the usability of this software is very good

7.1.7 Additional Functionality

It was a shame that I ran out of time to include the 'add interface', as it would have been of great use to the company. This function was always going to be a bit ambitious due to it's complexity. In order to produce a function that worked correctly and as generaly as needed, it would require a detailed input from the user. Details of the kind of information that would need to be obtained can be seen in Appendix U. The vast amount of information required indicates the complexity of this function but the actual coding would be a lot more intricate. After obtaining details of the specification from the user, the program would have to produce the correct code within the correct files to ensure all functions can be performed on the new interface. A window would need to be created in which the user would configure the interface. This window would need to contain the relevant fields for the user's input and at the same time must validate the data. On top of this, the new window would need to be linked in with the main window and the other function windows (adding/deleting nodes etc) to ensure all necessary fields are updated when required. As can be seen, this would be very time consuming but at the same time very beneficial, it is unfortunate that the problems with the GUI took so long to resolve or this functionality could have been attempted.

The User Guide will be of great use to the company and the SAINTT team members. Writing the User Guide went very well and smoothly with no problems. I managed to follow the planned methodology and run the program at the same time as writing the User Guide to ensure every detail was correct. Although at the time of evaluating I did not deliver the User Guide, it has since been sent to the team and their feedback was as follows

> The User Guide contains all the relevant information needed to run the Confuig Utility. The layout is in website form (as specified). From a website point of view, it is simple and to the point which is good since the general user will most probably be those with little technical knowledge or those new to SAINTT. In all, the User Guide will be of great benefit and we are able to add it on to the User Guide for the rest of SAINTT.

7.1.8 Testing

I feel the testing carried out was very efficient. By ensuring all test steps were carried out every time the test was run, I ensured that there were no bugs left in the system. Of course there could be bugs that I have not come across but by passing the program on to BAE Systems, I hoped these bugs would also be found.

Considering on the first run of the test I had to abort, the testing and fixing section of my project didn't take that much time. Most of the problems encountered were easily solved and solved correctly first time.

By performing two different types of testing (by myself and by someone else), I ensured that at least 99% of bugs were found and fixed. Using a secondary tester is also a benefit since they are more open to finding errors that I was unable to find - this is because they aren't used to the program and may try different chains of events or may make a mistake that shows up a bug. Overall I was impressed with my testing and making amendments.

7.1.9 Company Evaluation

An evaluation of the program, produced by the Technical Authority of SAINTT, can be seen in Appendix T.

In regards to the improvement features mentioned in the evaluation, I agree that porting to libglade is an area for improvement. It was always my intention to create the GUI using libglade (refered to just as Glade throughout this report) and, had the problems I experienced not occured or had they been fixed, this would be the case. When creating the menu items, I allocated an accelerator key to most of the functions but I did not get round to producing the coding to implement them. These would have been of great benefit to the more experienced and frequent users.

7.1.10 Improvements

Looking at the program as a whole, there are a few improvements that could be made to it. Firstly, a function to enable adding new interfaces to the program would be implicated, a function I had wanted to include but ran out of time.

Another improvement would be to allow the user to click into the tables containing the configured nodes and edit the details that way. This would be a benefit to the user since it would make it quicker

for the user to edit their configurations. It would also be beneficial to allow the user to 'right click' on a configured node and have the options to delete or edit the node - this again would enable the user to speed up the process.

7.1.11 Comparison of Other Products

Whilst carrying out research and when evaluating my program, I studied various resources in an attempt to find a product that would perform some of the functions my solution displays. I searched on the internet using various search criteria but could not find anything remotely similar. With regard to creating the physical IP Addresses, I could only find guides to take you through step by step how to do it, there did not appear to be any existing software that would do this for you. As for the rest of the program, I was unsure of what kind of program to look for. I tried 'configure interfaces', 'setting up networks', 'IP configuration tools' and many other variations but to no avail.

Since there were no real other products that could have been used for this, my program compares very well.

The program required was so specific to the company that it would have been impossible to use any existing product anyway. Since it was so specific and since my program meets all requirements, the program is very successful.

Appendix A: User Reflection

As a whole I found this project quite enjoyable. Although it proved to be quite stressful at times and there were times when I just wished it would all be over, when it was going well I found it interesting and good practice for real life.

Having previously done a project in my second year (for SE24), and carried out a years work placement, I felt I had learnt quite a lot about project management and time management. However, on both previous occasions I had worked within a group and wasn't prepared for how different working alone would be.

I feel the following 'tips' may be beneficial to prospective Project students:

Use LaTEX as soon as possible

If you are advised to do your report using LaTEX, I would advise you start using it as soon as possible. Although it isn't that hard a program to deal with, it can take a while to get used to the format. It can also take a while to work out how to do certain things in LaTEX, like creating tables for example. Also, it takes up a lot more time if you first write the report in Word and then transfere it to LaTEX. This is due to the fact that the files must be written in a .TEX file which must have no formatting in it.

Plan your program

Everyone knows it but very few do it. Planning your program code is an essential must for completing this project. As I experienced, problems occur where you least expect them and can severely delay your programming. It is a good idea to allow more time than you expect for each section of the coding as it never works out as planned and this way you shouldn't end up behind schedule (much.). Planning is

also a good way of preventing errors because it makes you think about what you are doing before you do it. Once possible errors have been identified, it is a lot easier to ensure you don't get stuck behind.

Usability

If you are designing a program to be used by people (what other kind of program is there?), ensure you take the look and feel of the program into account. Try to put yourself in their shoes and keep them in mind throughout. The system must meet the requirements of the user and it should be simple and self explanatory. The user has to 'enjoy' using the program in order to maximise the functionality of the system.

Think about your workload

It is important to look at how many modules you are doing in each semester and how much work you are going to be set. The way I chose my modules worked out extremely well. Although I split my modules 50/50 between the two semesters, I chose them so that in the second semester I only had one module which required coursework. This meant that I had lots of spare time in the second semester which is when the majority of the project was completed. Since there is always a rush near the hand in date, I would advise prospective students to choose their modules with this in mind.

Be sure before doing a project for a third party

If you are considering doing a project for a company or third party, make sure you really think about it. The problem must be suitable for the project and even though you may think this is the case, others may not. If possible, talk the problem through with someone within the Project team before hand. I advise talking to the company or third party before carrying out the project to explain that you may need to alter certain aspects in order that it suits the project.

When doing my project, I found it very hard to explain exactly what it was that BAE Systems wanted from me and although my project was approved and my suporvisor agreed it was suitable, it became clear at my progress meeting with my assessor that he was unsure it was.

Based on my experiences, I wouldn't actually advise chosing your project to be for a company, I feel it caused more problems than had I have done a project where the problem was specifically written with a project in mind.

Appendix B: Tasking Memo

The following document is a Tasking Memo provided to me by the SAINTT team at BAE Systems. It contains details of what the problem is and some requirements for the solution.

To:	Jen Poole		
Cc:			
From:	Anonymous SAINTT Team member	**Internal Tel:**	
Div/Dept:		**Internal Fax:**	
Date:		**Tel:**	
Ref:		**Fax:**	
Pages:	3	**Email:**	
Subject:	Tasking Memo for Config Utility		

1 Introduction

1 At present, the configuration of a SAINTT system is controlled by two files: .cse_definitions and ip_aliasing. The first of these files relates node Ids to IP addresses through environment variables in the Linux operating system. The second file is a script that runs upon booting the SAINTT system and creates virtual network cards known as aliases. These files must be edited by hand each time the configuration of SAINTT changes. That is, each time the connected nodes are changed or the mode of operation of the system (SimEng or Coupler) is changed, the aforementioned files must be edited. This requires system administrator (root) access and also intimate knowledge of how the information in these files is formatted and used.

2 The SAINTT configuration utility aims to make the configuration of a SAINTT system much simpler. It will allow a casual user to configure the system without requiring system administrator privileges. It will also avoid the need for the user to know in detail how each configuration file is used by SAINTT. Therefore, the CMS and applications teams will be able to take control of their own system configurations without requiring the SAINTT team's assistance every time their configuration changes. Users will be able to create multiple configurations for a SAINTT system and manage them using simple, user-friendly menus.

3 This memo contains the following details on the Tasking Memo for Config Utility proposed

- Requirements;
- Assumptions/Requirements Interpretation;
- Limitations;
- Acceptance Criteria;
- Design Overview
- Detailed Design;
- Affected File List;
- Test procedure;
- Quote Information.

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2 Requirements

SAINTT will be modified to meet the following requirements:

- A SAINTT configuration utility is required to replace the existing configuration methods. This utility shall not require system administrator privileges and shall create all the configuration files SAINTT requires.
- The SAINTT configuration utility shall allow the user to easily select the mode of operation and the nodes to be connected to the system. The utility shall provide modes of operation on both the DTS and company networks.

3 Assumptions/Requirements Interpretation

4 Requirements Interpretation

5 Limitations

4 There are no limitations associated with this change.

6 Acceptance Criteria

5 empty

7 Design Overview

7.1 Overview

6 This will be used for the setup of IP interfaces

7.2 Layout (Look and Feel)

1 The main window will contain the options for the overview setup. This will include the ability to edit:

- Setup files directory
- Override template directory
- The maximum file size
- The card type

2 As well as the above the following will also be displayed

- The baseline templates directory (default templates)
- A summary of the currently configured interfaces

3 The user should be able to save configurations, and load saved configurations

4 The main page will also contain access to the setup for each interface type.

5 Each interface specific setup page should contain a more detailed summary of the interfaces currently set up, including the node ids IP addresses and port numbers.

6 At all stages the input from the user will be validated

7.3 Overview – Code

1 The program should ensure that the correct number of sockets for each interface is given and if the interface has a limit on the number of nodes that can be configured, it should ensure that these are met.

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2 The program should also contain defaults, where appropriate, for instance the port numbers or IP addresses. If the user loads an invalid file, the default values for the setup and ports should be used.

3 When a user adds a node, the default IP address for that node will appear, the user may change it if they wish to,

4 The default port numbers will appear, again the user may change them if they wish

5 The Config Utility will output a file, which will represent the configuration

6 This file will be parsed and used by the simulator (outside of the scope of this work)

7 The output will be similar to the current comms_config.dat file, containing the values of the IP addresses and ports needed by the simulator to create a particular interface.

8 A sample of the (modified) comms_config.dat file

```
INT LEN_THIRD_PORT 20001
INT LEN_SECOND_PORT 20002
INT LEN_FIRST_PORT 20003
INT MAXIMUM_FILE_SIZE 500
STRING LOCAL_LEN_IP_ADDRESS_23 "164.23.46.1"
STRING LOCAL_LEN_IP_ADDRESS_3 "164.3.46.1"
STRING REMOTE_LEN_IP_ADDRESS_23 "164.3.46.3"
STRING REMOTE_LEN_IP_ADDRESS_3 "164.3.46.3"
STRING TSM_TRANSMISSION_METHOD "DTS_MODE"
INT_ARRAY LEN_Card0_Nodes 3 23 3
INT_ARRAY LEN_Card1_Nodes 0
```

9 I've named the interface type Len

10 The output will also contain the IP aliasing information; again this will be parsed by the simulator, which will perform the IP aliasing at startup.

11 As at present the Config Utility will 'remember' the current configuration by reading in the comms_config.dat, the new Config Utility should be able to do the same by reading in the output.

12 At present there is a set of entries in the comms_config.dat file that will tell the Config Utility which card each configured node is on. In the above example these are the INT ARRAY entries. Though there is no harm in this, this information is superfluous, as it can be worked out from the IP aliasing information.

13 Those entries are also there to tell the Config Utility which of the nodes in the file are actually configured. This is because entries are never deleted from the file. Ideally the output file will only consist of the nodes that are configured, so the extra info is not required.

14 Because the output is one file, this is all that is needed to be saved to save the configuration. This will make saving and loading configurations simple to implement.

8 Detailed Design

9 Test Procedure

10 Quote Information

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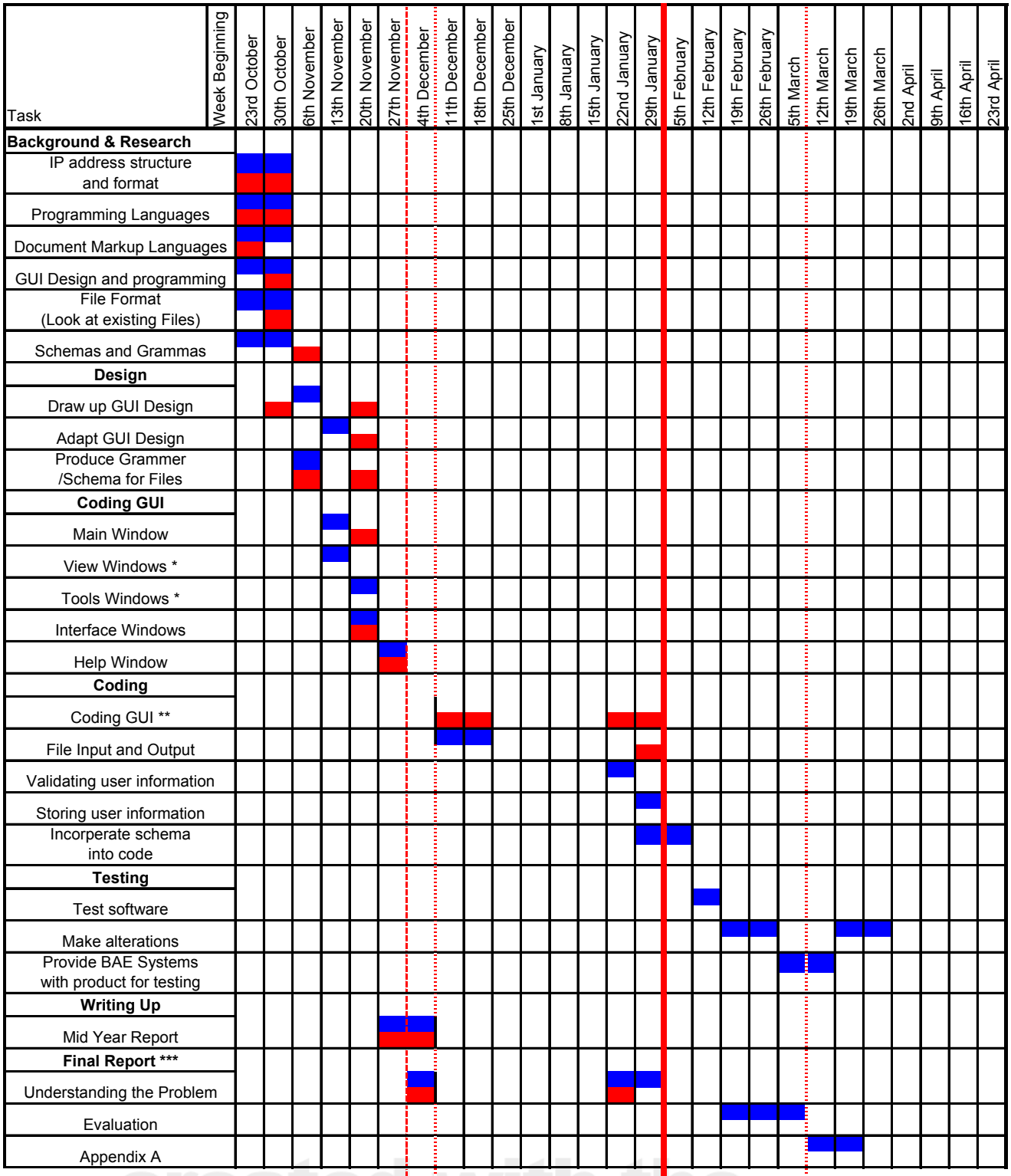
Team-leader's name
SAINTT Team Leader

Appendix C: Gantt Charts

This appendix shows the first Gantt Chart created and then the revised schedule once it was clear that coding the GUI wasn't working.



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Key

Proposed Work

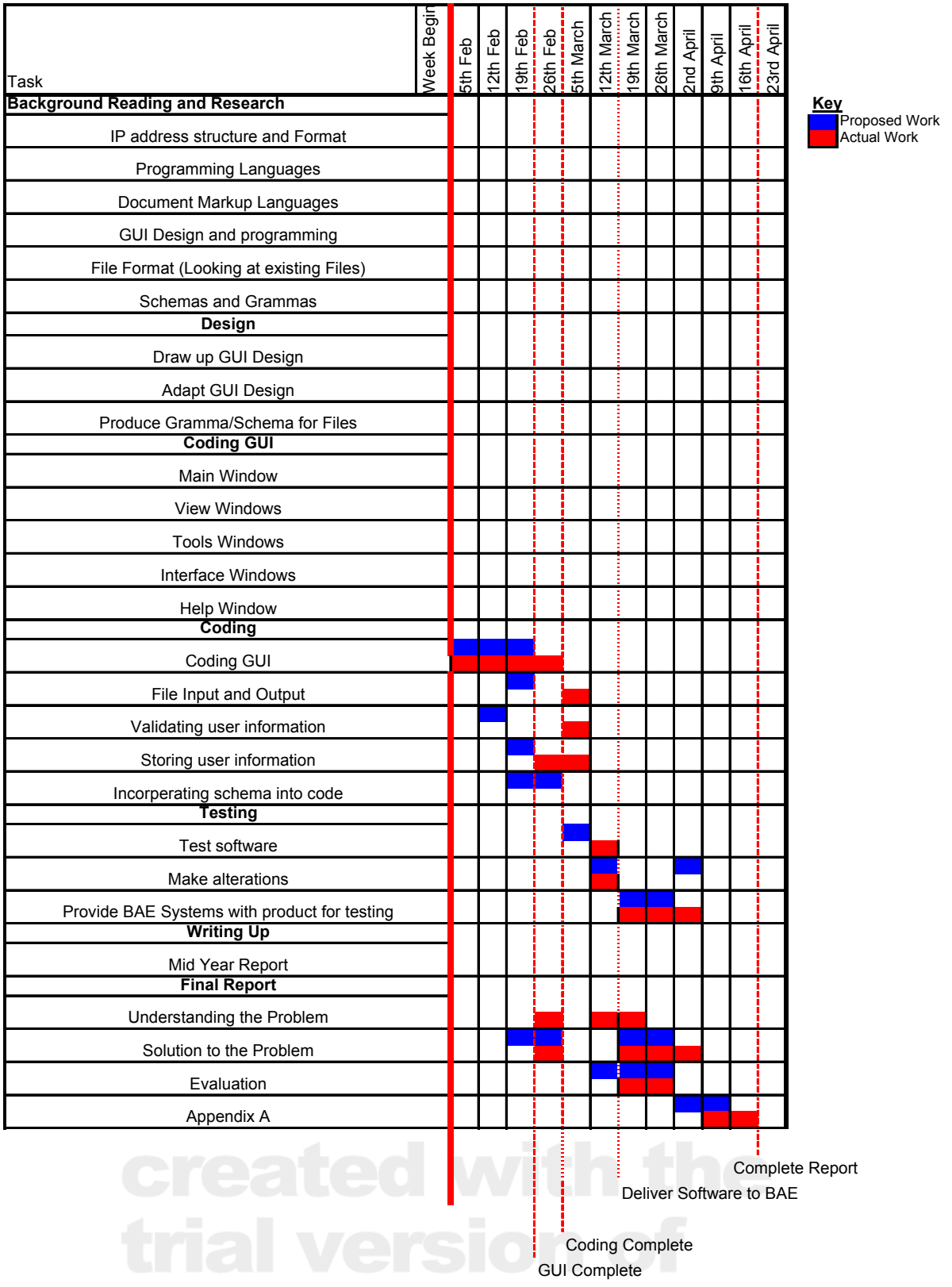
Actual Work

* This section of the GUI is no longer needed

** This section was added on 11th December
Causing many problems - can't link signals!

*** This section was added to split up the sections of the report

Schedule 2:



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Appendix D: Past Configuration File

An example of the old configuration file can be seen in the document in Appendix B or here:

```
INT LEN_THIRD_PORT 20001
INT LEN_SECOND_PORT 20002
INT LEN_FIRST_PORT 20003
INT MAXIMUM_FILE_SIZE 500
STRING LOCAL_LEN_IP_ADDRESS_23 "164.23.46.1"
STRING LOCAL_LEN_IP_ADDRESS_3 "164.3.46.1"
STRING REMOTE_LEN_IP_ADDRESS_23 "164.3.46.3"
STRING REMOTE_LEN_IP_ADDRESS_3 "164.3.46.3"
STRING TSM_TRANSMISSION_METHOD "DTS_MODE"
INT_ARRAY LEN_Card0_Nodes 3 23 3
INT_ARRAY LEN_Card1_Nodes 0
```

Where the interface name is LEN.

Appendix E: Tutorial Notes

- Schema must have a root element
- The content model of the root element consists of compositors and components
- The compositors specify a relationship between two components
- Compositor is one of: sequence, choice or all
  - Sequence: The elements must follow the specified sequence
  - Choice: ???
  - All: ???
- To add a child element to a component, you must first add a compositor
- Elements can be complex or simple type
- A complex type contains attributes and/or elements
- Global complex/simple types are objects that can be used within all other global components
- An element that references a global element must have the same name as the global element it references
- A global declaration does not describe where a component is to be used in an XML document, it only describes a content model

- It is only when a global declaration is referenced from within another component that its location in the XML document is specified
- A globally declared element can be reused at multiple locations
- It differs from a globally declared complex type in that its content model can not be modified without also modifying the global element itself
- If you change the content model of an element that references a global element, then the content model of the global element will also be changed, and, with it, the content model of all other elements that reference the global element
- An element can have attributes
- Attributes can be made optional, required or prohibited
- Attributes can have enumerations, defaults and fixed values specified

Appendix F: New Configuration File

```
<?xml version="1.0" encoding="UTF-8" standalone="yes" ?>
<!DOCTYPE XML>

<Configuration

  <Interface1>

    <DTS>
      <InterfaceType>DTS</InterfaceType>
      <NodeId>8</NodeId>
      <Socket>
        <Name>DTS</Name>
        <Local-IP-Address>
          <Term>1</Term>
          <Seperator>.</Seperator>
          <Term>2</Term>
          <Seperator>.</Seperator>
          <Term>8</Term>
          <Seperator>.</Seperator>
          <Term>3</Term>
        </Local-IP-Address>
        <Remote-IP-Address>
          <Term>1</Term>
          <Seperator>.</Seperator>
          <Term>2</Term>
          <Seperator>.</Seperator>
          <Term>8</Term>
          <Seperator>.</Seperator>
          <Term>4</Term>
        </Remote-IP-Address>
        <Port>
          <LocalHeartbeat>6001</LocalHeartbeat>
          <DestinationHeartbeat>6002</DestinationHeartbeat>
          <Management>6003</Management>
          <Reliable>6004</Reliable>
          <LocalUnreliable>6005</LocalUnreliable>
          <DestinationUnreliable>6006</DestinationUnreliable>
        </Port>
      </Socket>
      <ExtraInformation>
        <Card>0</Card>
      </ExtraInformation>
    </DTS>

    <RealCoupler>
      <InterfaceType>Real Coupler</InterfaceType>
      <NodeId>4</NodeId>
      <Socket>
        <Name>Real Coupler</Name>
        <Local-IP-Address>
          <Term>1</Term>
          <Seperator>.</Seperator>
          <Term>2</Term>
          <Seperator>.</Seperator>
          <Term>4</Term>
          <Seperator>.</Seperator>
          <Term>3</Term>
        </Local-IP-Address>
        <Remote-IP-Address>
          <Term>1</Term>
```

```
      <Seperator>.</Seperator>
      <Term>2</Term>
      <Seperator>.</Seperator>
      <Term>4</Term>
      <Seperator>.</Seperator>
      <Term>4</Term>
    </Remote-IP-Address>
    <Port>
      <LocalHeartbeat>6002</LocalHeartbeat>
      <DestinationHeartbeat>6001</DestinationHeartbeat>
      <Management>6004</Management>
      <Reliable>6003</Reliable>
      <LocalUnreliable>6006</LocalUnreliable>
      <DestinationUnreliable>6005</DestinationUnreliable>
    </Port>
  </Socket>
  <ExtraInformation>
    <Card>0</Card>
    <TSM-TransmissionMethod>VLAN Mode</ TSM-TransmissionMethod>
    <ATE-Enabled>Yes</ ATE-Enabled>
  </ExtraInformation>
</RealCoupler>

<SimSAF>
  <InterfaceType>Sim SAF</InterfaceType>
  <NodeId>5</NodeId>
  <Socket>
    <Name>Sim SAF</Name>
    <Local-IP-Address>
      <Term>1</Term>
      <Seperator>.</Seperator>
      <Term>2</Term>
      <Seperator>.</Seperator>
      <Term>5</Term>
      <Seperator>.</Seperator>
      <Term>3</Term>
    </Local-IP-Address>
    <Remote-IP-Address>
      <Term>1</Term>
      <Seperator>.</Seperator>
      <Term>2</Term>
      <Seperator>.</Seperator>
      <Term>5</Term>
      <Seperator>.</Seperator>
      <Term>4</Term>
    </Remote-IP-Address>
    <Port>
      <Local>1000</Local>
      <Remote>1001</Remote>
    </Port>
  </Socket>
  <ExtraInformation>
    <Card>0</Card>
  </ExtraInformation>
</Sim SAF>

<CSH>
  <InterfaceType>CSH</InterfaceType>
  <NodeId>6</NodeId>
  <Socket>
```

```
      <Name>Sim SAF</Name>
      <Local-IP-Address>
        <Term>1</Term>
        <Seperator>.</Seperator>
        <Term>2</Term>
        <Seperator>.</Seperator>
        <Term>6</Term>
        <Seperator>.</Seperator>
        <Term>3</Term>
      </Local-IP-Address>
      <Port>
        <LinkPort>2000</LinkPort>
      </Port>
    </Socket>
    <ExtraInformation>
      <Card>0</Card>
    </ExtraInformation>
  </CSH>

  <Snoop>
    <InterfaceType>Snoop</InterfaceType>
    <NodeId>10</NodeId>
    <Local-IP-Address>
      <Term>1</Term>
      <Seperator>.</Seperator>
      <Term>2</Term>
      <Seperator>.</Seperator>
      <Term>10</Term>
      <Seperator>.</Seperator>
      <Term>3</Term>
    </Local-IP-Address>
  </Snoop>

</Interface1>

<Interface2>

  <LPD>
    <InterfaceType>LPD</InterfaceType>
    <NodeId>9</NodeId>
    <Socket>
      <Name>LPD</Name>
      <Local-IP-Address>
        <Term>1</Term>
        <Seperator>.</Seperator>
        <Term>2</Term>
        <Seperator>.</Seperator>
        <Term>9</Term>
        <Seperator>.</Seperator>
        <Term>3</Term>
      </Local-IP-Address
    </Socket>
    <ExtraInformation>
      <Card>0</Card>
    </ExtraInformation>
  </CSH>

</Interface2>

<MaxFileSize>300</MaxFileSize>
```

```
  <NetworkType>znb</NetworkType>
  <DefaultTemplateDirectory>~/.default_templates/</DefaultTemplateDirectory>
  <OverrideTemplateDirectory>/home/jen4003/Documents</OverrideTemplateDirectory>
  <CurrentSetupDirectory>/home/jen4003/configurations</CurrentSetupDirectory>
</Configuration>
```

Appendix G: Schema Design

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- edited with XMLSpy v2007 (http://www.altova.com) by Jennfer (Manze) -->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualif
ied" attributeFormDefault="unqualified">
    <xs:element name="Configuration">
        <xs:annotation>
            <xs:documentation>Root Element</xs:documentation>
        </xs:annotation>
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Interface1" maxOccurs="unbounded">
                    <xs:complexType>
                        <xs:choice>
                            <xs:element name="DTS" type="DTSInterfaceType" maxOcc
urs="unbounded"/>
                            <xs:element name="RealCoupler" type="CouplerInterface
Type" maxOccurs="unbounded"/>
                            <xs:element name="CSH" type="CSHInterfaceType"/>
                            <xs:element name="SimSAF" type="SimSAFInterfaceType"/
>
                            <xs:element name="Snoop" type="SnoopInterfaceType" ma
xOccurs="unbounded"/>
                        </xs:choice>
                    </xs:complexType>
                </xs:element>
                <xs:element name="Interface2" minOccurs="0">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="LPD" type="LPDInterfaceType"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
                <xs:element name="MaxFileSize">
                    <xs:simpleType>
                        <xs:restriction base="xs:unsignedShort">
                            <xs:minInclusive value="100"/>
                            <xs:maxInclusive value="1700"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="NetworkType">
                    <xs:simpleType>
                        <xs:restriction base="xs:string">
                            <xs:enumeration value="eth"/>
                            <xs:enumeration value="znb"/>
                        </xs:restriction>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="DefaultTemplateDirectory">
                    <xs:simpleType>
                        <xs:restriction base="xs:string"/>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="OverrideTemplateDirectory">
                    <xs:simpleType>
                        <xs:restriction base="xs:string"/>
                    </xs:simpleType>
                </xs:element>
                <xs:element name="CurrentSetupDirectory">
                    <xs:simpleType>
                        <xs:restriction base="xs:string"/>
                    </xs:simpleType>
                </xs:element>
            </xs:sequence>
```

```
        </xs:complexType>
    </xs:element>
    <xs:complexType name="IPAddressType">
        <xs:annotation>
            <xs:documentation>Template for IP Addresses</xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element name="Term" type="TermType"/>
            <xs:element name="Seperator" type="SeperatorType" fixed="."/>
            <xs:element name="Term" type="TermType"/>
            <xs:element name="Seperator" type="SeperatorType" fixed="."/>
            <xs:element name="Term" type="TermType"/>
            <xs:element name="Seperator" type="SeperatorType" fixed="."/>
            <xs:element name="Term" type="TermType"/>
        </xs:sequence>
    </xs:complexType>
    <xs:simpleType name="TermType">
        <xs:restriction base="xs:int">
            <xs:minInclusive value="0"/>
            <xs:maxInclusive value="255"/>
            <xs:pattern value="\p{N}"/>
            <xs:pattern value="\p{N}\p{N}"/>
            <xs:pattern value="\p{N}\p{N}\p{N}"/>
        </xs:restriction>
    </xs:simpleType>
    <xs:simpleType name="SeperatorType">
        <xs:restriction base="xs:string">
            <xs:length value="1"/>
            <xs:enumeration value="."/>
        </xs:restriction>
    </xs:simpleType>
    <xs:complexType name="DTSInterfaceType">
        <xs:annotation>
            <xs:documentation>Template for DTS Interface</xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element name="InterfaceType" fixed="DTS">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="Real Coupler"/>
                        <xs:enumeration value="DTS"/>
                        <xs:enumeration value="LPD"/>
                        <xs:enumeration value="CSH"/>
                        <xs:enumeration value="SimSAF"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="NodeId">
                <xs:simpleType>
                    <xs:restriction base="xs:unsignedInt">
                        <xs:minInclusive value="0"/>
                        <xs:maxInclusive value="255"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Socket">
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="Name" type="xs:string" fixed="DTS"/>
                        <xs:element name="Local-IP-Address" type="IPAddressType"/
>
                        <xs:element name="Remote-IP-Address" type="IPAddressType"
/>
                        <xs:element name="Port">
```

```
                            <xs:complexType>
                                <xs:sequence>
                                    <xs:element name="LocalHeartbeat" type="xs:in
t"/>
                                    <xs:element name="DestinationHeartbeat" type=
"xs:int"/>
                                    <xs:element name="Management" type="xs:int"/>
                                    <xs:element name="Reliable" type="xs:int"/>
                                    <xs:element name="LocalUnreliable" type="xs:i
nt"/>
                                    <xs:element name="DestinationUnreliable" type
="xs:int"/>
                                </xs:sequence>
                            </xs:complexType>
                        </xs:element>
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
            <xs:element name="ExtraInformation">
                <xs:complexType>
                    <xs:all>
                        <xs:element name="Card">
                            <xs:simpleType>
                                <xs:restriction base="xs:int">
                                    <xs:enumeration value="1"/>
                                    <xs:enumeration value="0"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                    </xs:all>
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="CouplerInterfaceType">
        <xs:annotation>
            <xs:documentation>Template for Coupler Interface</xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element name="InterfaceType" fixed="Real Coupler">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="Real Coupler"/>
                        <xs:enumeration value="DTS"/>
                        <xs:enumeration value="LPD"/>
                        <xs:enumeration value="CSH"/>
                        <xs:enumeration value="SimSAF"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="NodeId">
                <xs:simpleType>
                    <xs:restriction base="xs:unsignedInt">
                        <xs:minInclusive value="0"/>
                        <xs:maxInclusive value="255"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Socket">
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="Name" type="xs:string" fixed="Real Coup
ler"/>
                        <xs:element name="Local-IP-Address" type="IPAddressType"/
```

```
>
                        <xs:element name="Remote-IP-Address" type="IPAddressType"
/>
                        <xs:element name="Port">
                            <xs:complexType>
                                <xs:sequence>
                                    <xs:element name="LocalHeartbeat" type="xs:in
t"/>
                                    <xs:element name="DestinationHeartbeat" type=
"xs:int"/>
                                    <xs:element name="Management" type="xs:int"/>
                                    <xs:element name="Reliable" type="xs:int"/>
                                    <xs:element name="LocalUnreliable" type="xs:i
nt"/>
                                    <xs:element name="DestinationUnreliable" type
="xs:int"/>
                                </xs:sequence>
                            </xs:complexType>
                        </xs:element>
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
            <xs:element name="ExtraInformation">
                <xs:complexType>
                    <xs:all>
                        <xs:element name="Card">
                            <xs:simpleType>
                                <xs:restriction base="xs:int">
                                    <xs:enumeration value="1"/>
                                    <xs:enumeration value="0"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                        <xs:element name="TSM-TransmissionMethod">
                            <xs:simpleType>
                                <xs:restriction base="xs:string">
                                    <xs:enumeration value="DTS Mode"/>
                                    <xs:enumeration value="VLAN Mode"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                        <xs:element name="ATE-Enabled" minOccurs="0">
                            <xs:complexType>
                                <xs:attribute name="port" use="required" type="xs
:unsignedInt"/>
                            </xs:complexType>
                        </xs:element>
                    </xs:all>
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="SimSAFInterfaceType">
        <xs:annotation>
            <xs:documentation>Template for SimSAF Interface</xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element name="InterfaceType" fixed="SimSAF">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="Real Coupler"/>
                        <xs:enumeration value="DTS"/>
                        <xs:enumeration value="LPD"/>
                        <xs:enumeration value="CSH"/>
```

```
                        <xs:enumeration value="SimSAF"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="NodeId">
                <xs:simpleType>
                    <xs:restriction base="xs:unsignedInt">
                        <xs:minInclusive value="0"/>
                        <xs:maxInclusive value="255"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Socket">
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="Name" type="xs:string" fixed="SimSAF"/>
                        <xs:element name="Local-IP-Address" type="IPAddressType"/
>
                        <xs:element name="Remote-IP-Address" type="IPAddressType"
/>
                        <xs:element name="Port" minOccurs="2" maxOccurs="2">
                            <xs:complexType>
                                <xs:sequence>
                                    <xs:element name="Local" type="xs:int"/>
                                    <xs:element name="Remote" type="xs:int"/>
                                </xs:sequence>
                            </xs:complexType>
                        </xs:element>
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
            <xs:element name="ExtraInformation">
                <xs:complexType>
                    <xs:all>
                        <xs:element name="Card">
                            <xs:simpleType>
                                <xs:restriction base="xs:int">
                                    <xs:enumeration value="1"/>
                                    <xs:enumeration value="0"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                    </xs:all>
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="CSHInterfaceType">
        <xs:annotation>
            <xs:documentation>Template for CSH Interface</xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element name="InterfaceType" fixed="CSH">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="Real Coupler"/>
                        <xs:enumeration value="DTS"/>
                        <xs:enumeration value="LPD"/>
                        <xs:enumeration value="CSH"/>
                        <xs:enumeration value="SimSAF"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="NodeId">
```

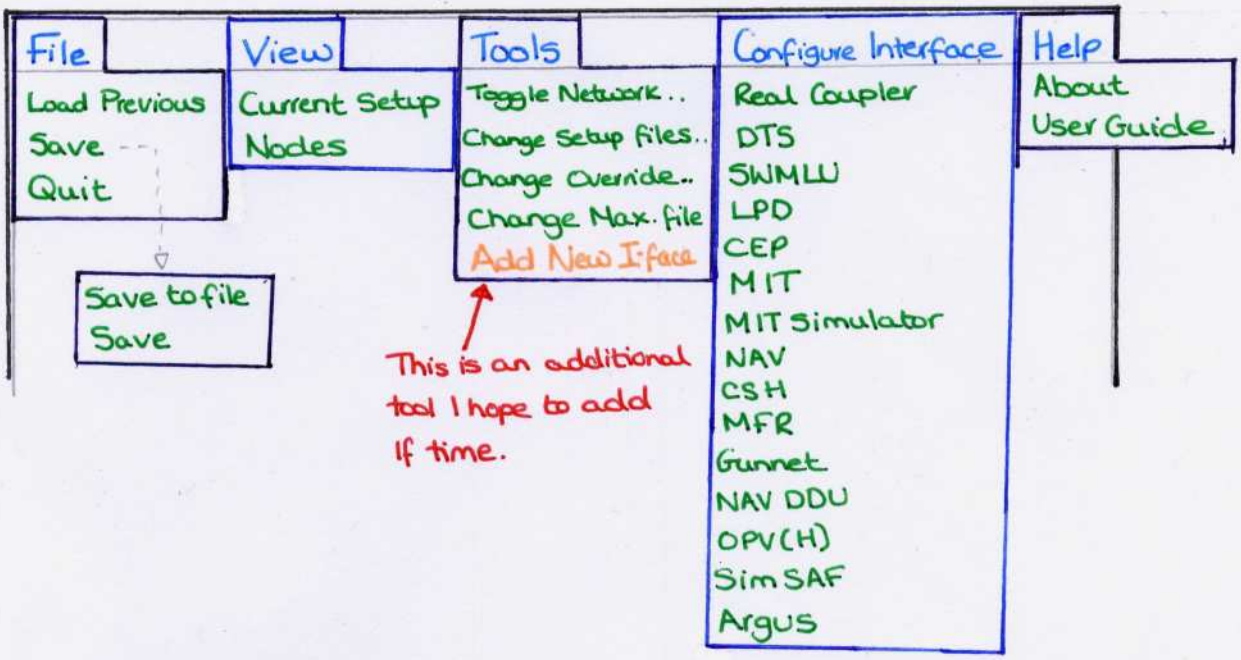
```
                <xs:simpleType>
                    <xs:restriction base="xs:unsignedInt">
                        <xs:minInclusive value="0"/>
                        <xs:maxInclusive value="255"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Socket">
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="Name" type="xs:string" fixed="CSH"/>
                        <xs:element name="Local-IP-Address" type="IPAddressType"/
>
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
            <xs:element name="ExtraInformation">
                <xs:complexType>
                    <xs:all>
                        <xs:element name="Card">
                            <xs:simpleType>
                                <xs:restriction base="xs:int">
                                    <xs:enumeration value="1"/>
                                    <xs:enumeration value="0"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                    </xs:all>
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="LPDInterfaceType">
        <xs:annotation>
            <xs:documentation>Template for LPD Interface</xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element name="InterfaceType" fixed="LPD">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="Real Coupler"/>
                        <xs:enumeration value="DTS"/>
                        <xs:enumeration value="LPD"/>
                        <xs:enumeration value="CSH"/>
                        <xs:enumeration value="SimSAF"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="NodeId">
                <xs:simpleType>
                    <xs:restriction base="xs:unsignedInt">
                        <xs:minInclusive value="0"/>
                        <xs:maxInclusive value="255"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Socket">
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="Name" type="xs:string" fixed="LPD"/>
                        <xs:element name="Local-IP-Address" type="IPAddressType"/
>
                        <xs:element name="Port">
                            <xs:complexType>
```

```
                                <xs:sequence>
                                    <xs:element name="LinkPort" type="xs:int"/>
                                </xs:sequence>
                            </xs:complexType>
                        </xs:element>
                    </xs:sequence>
                </xs:complexType>
            </xs:element>
            <xs:element name="ExtraInformation">
                <xs:complexType>
                    <xs:all>
                        <xs:element name="Card">
                            <xs:simpleType>
                                <xs:restriction base="xs:int">
                                    <xs:enumeration value="1"/>
                                    <xs:enumeration value="0"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:element>
                    </xs:all>
                </xs:complexType>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="SnoopInterfaceType">
        <xs:annotation>
            <xs:documentation>Template for Snoop Interface</xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element name="InterfaceType" fixed="DTS">
                <xs:simpleType>
                    <xs:restriction base="xs:string"/>
                </xs:simpleType>
            </xs:element>
            <xs:element name="NodeId">
                <xs:simpleType>
                    <xs:restriction base="xs:unsignedInt">
                        <xs:minInclusive value="0"/>
                        <xs:maxInclusive value="255"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:element>
            <xs:element name="Local-IP-Address" type="IPAddressType"/>
        </xs:sequence>
    </xs:complexType>
</xs:schema>
```

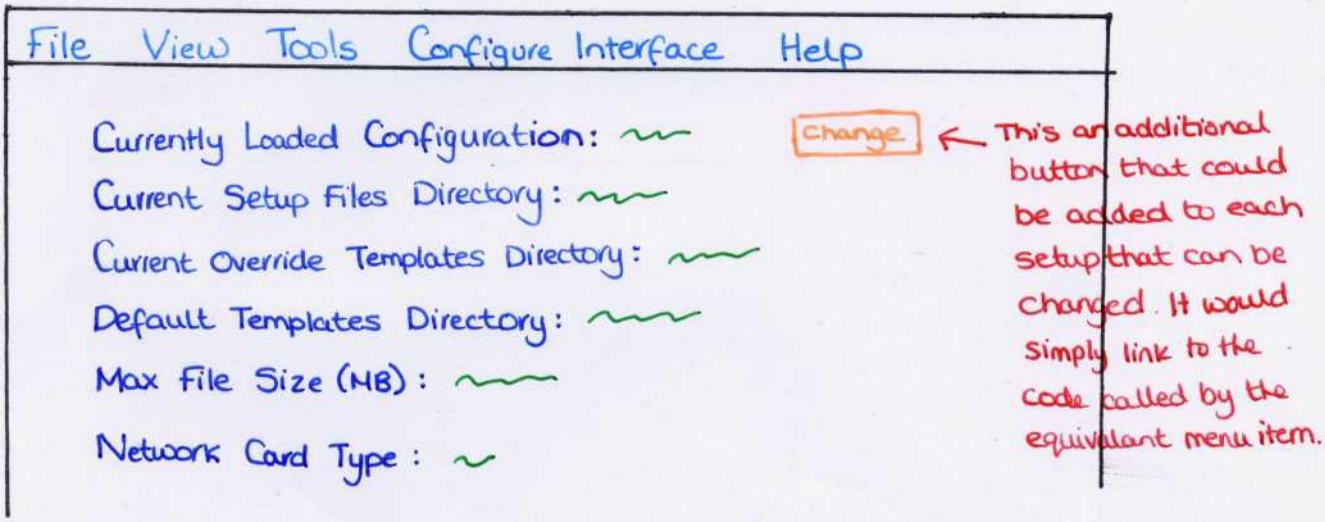
Appendix H: GUI Design

Gui Design

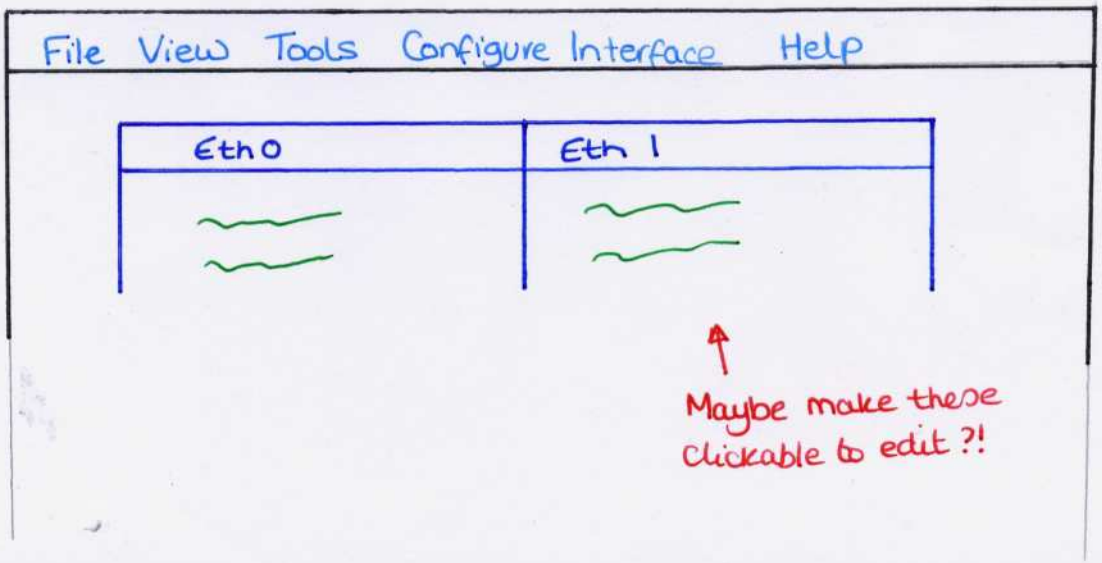
Menu



Current Setup


File View Tools Configure Interface Help
Currently Loaded Configuration:
Change
This is an additional button that could be added to each setup that can be changed. It would simply link to the code called by the equivalent menu item.
Current Setup Files Directory:
Current Override Templates Directory:
Default Templates Directory:
Max File Size (MB):
Network Card Type:

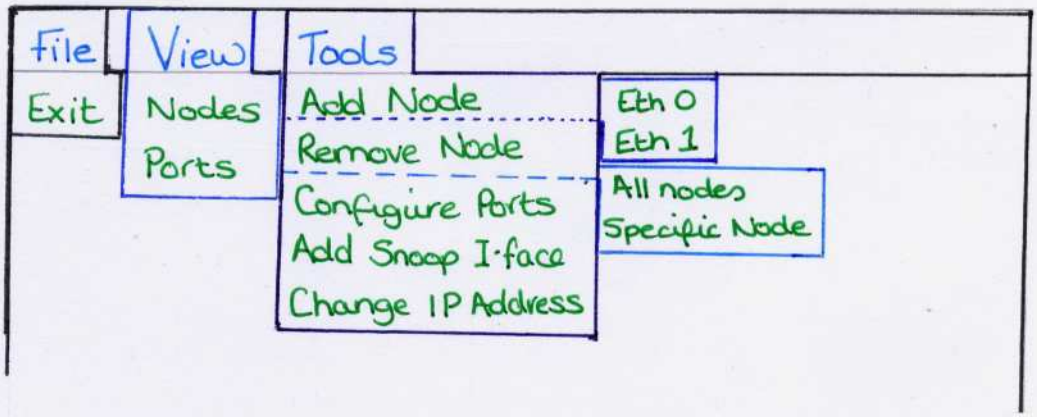
Nodes



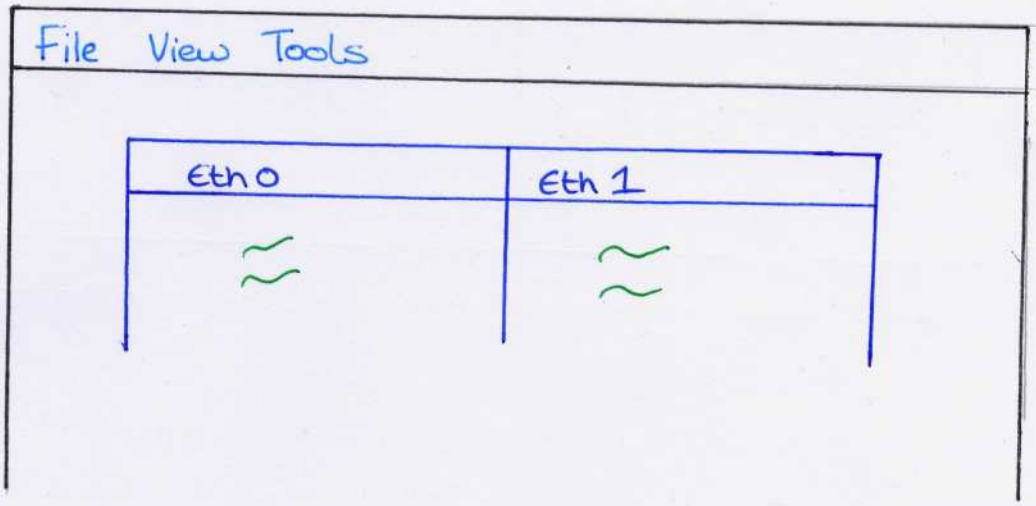
A sample Configure Interface Window (DTS)

Popup Window

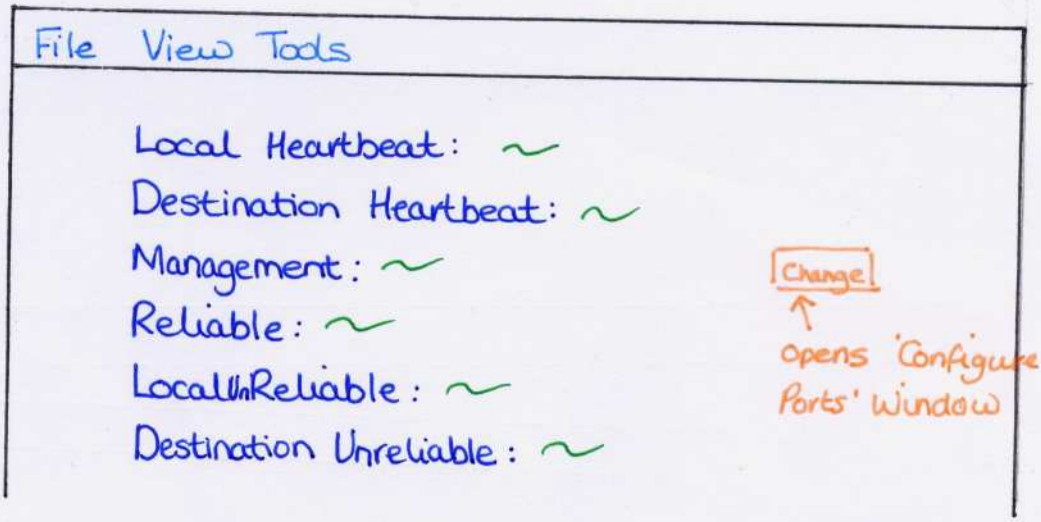
Menu



Nodes

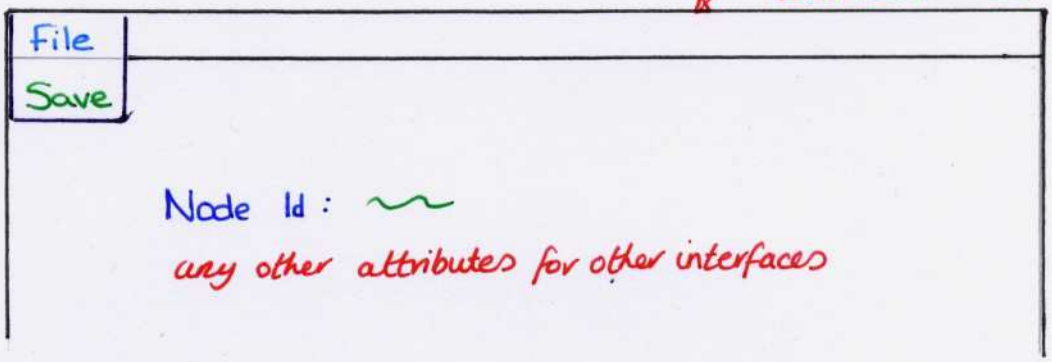


Ports



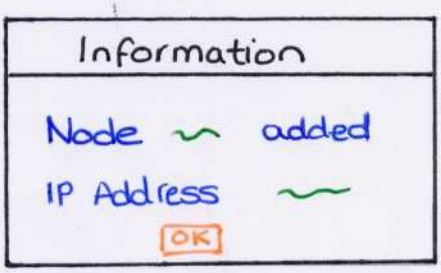
Popup Window

Add Node
→ Eth 0
(will be same GUI for eth1)



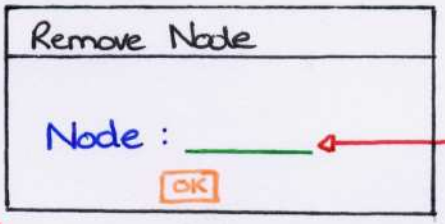
May be better as a dialogue with save button if no other menu options.

- Popup dialogue to let you know your node has been saved



Information Windows like this will be produced after removing nodes and adding Snoop.

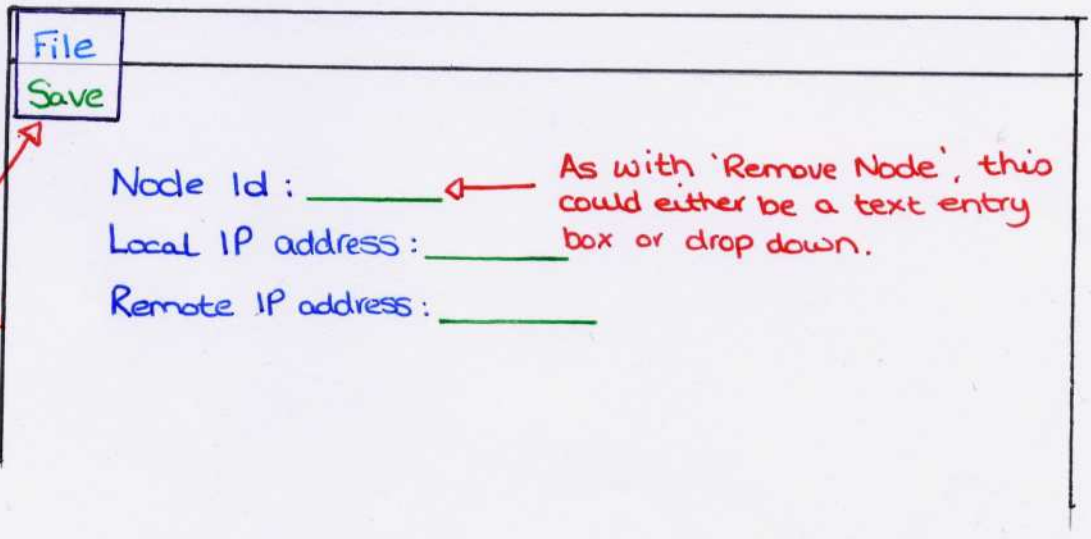
Remove Node
→ Specific Node
Popup Window



This could be a siple text entry or a drop down containing all nodes currently configured on that interface.

A dialogue like this will be used to add Snoop Interface

Change IP Address

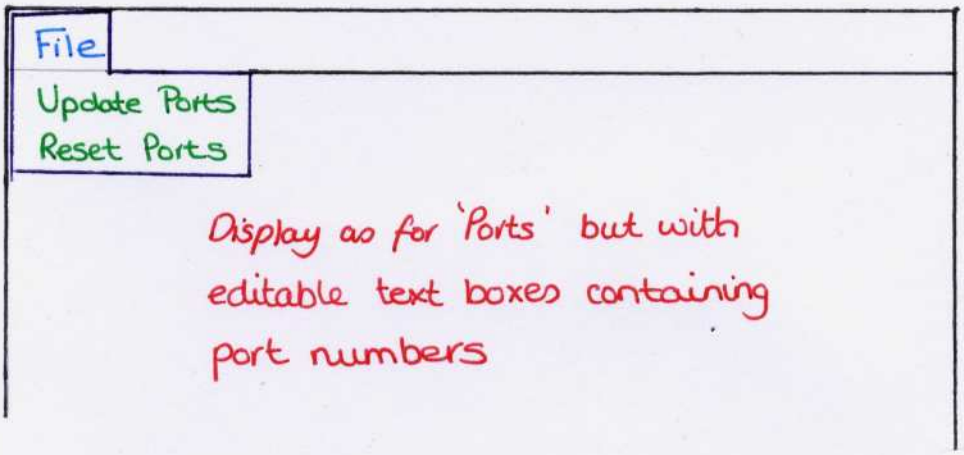


As with 'Remove Node', this could either be a text entry box or drop down.

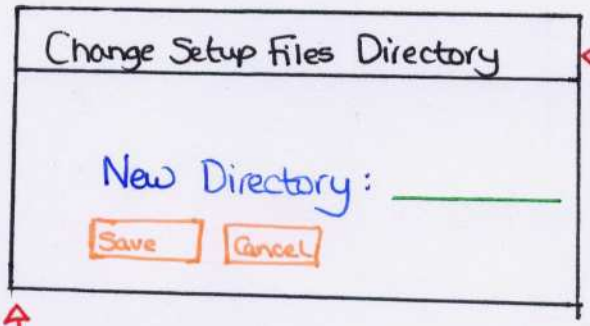
Again, may be better to have dialogue with save button if no other menu options.

Popup Window

Configure Ports



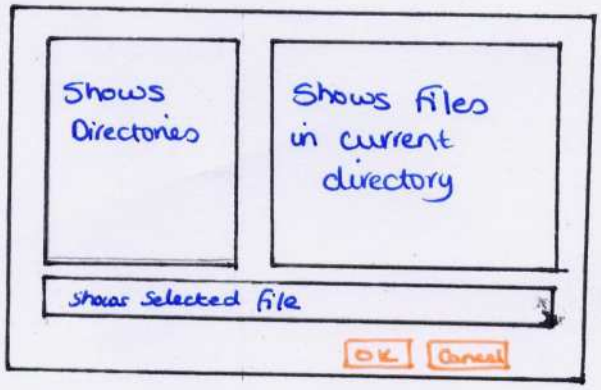
Dialogue for Changing Setup Files etc...



← This design would be used for changing override templates directory and change max. file size.

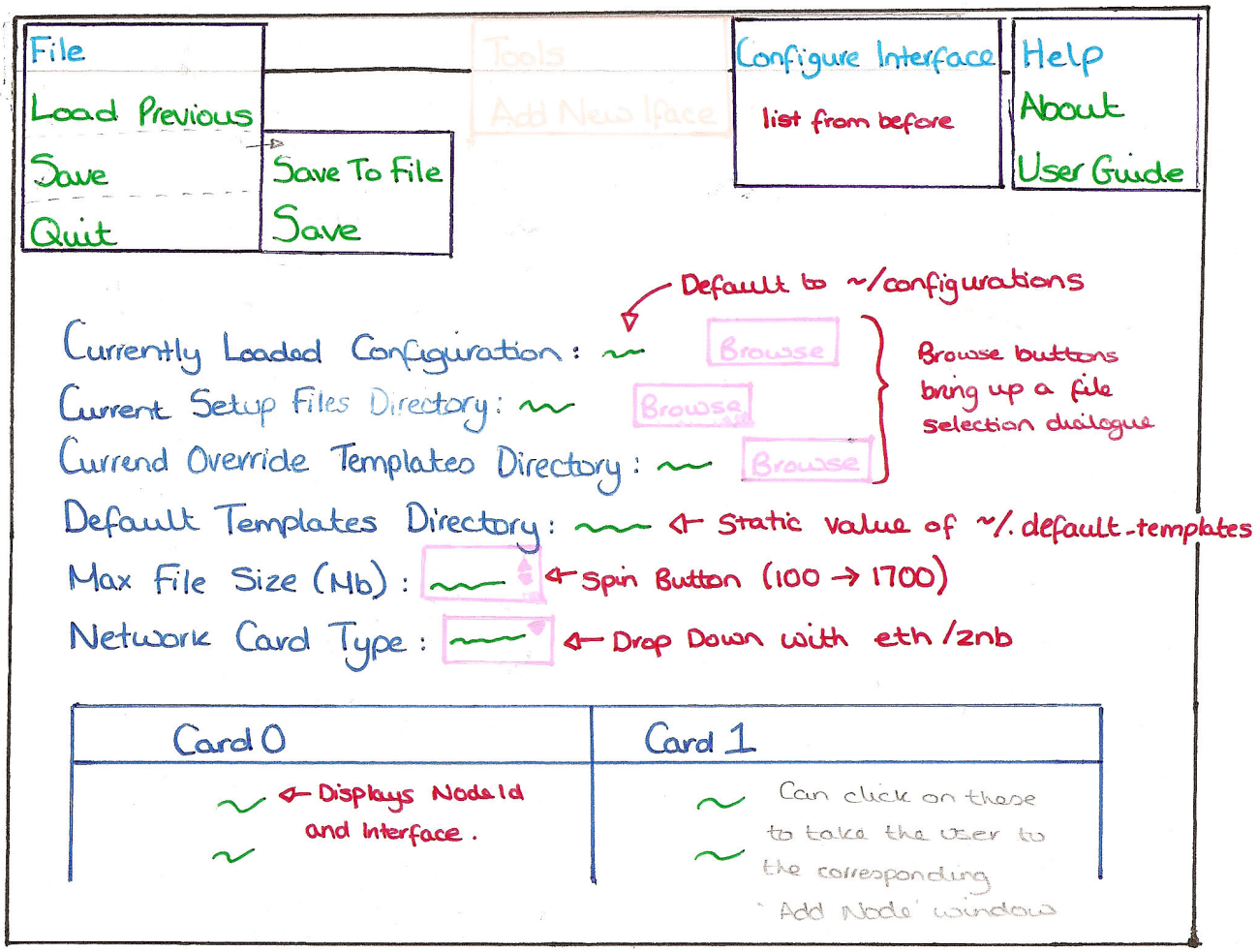
↑ Would produce an information dialogue to let you know success or failure

Load Previous



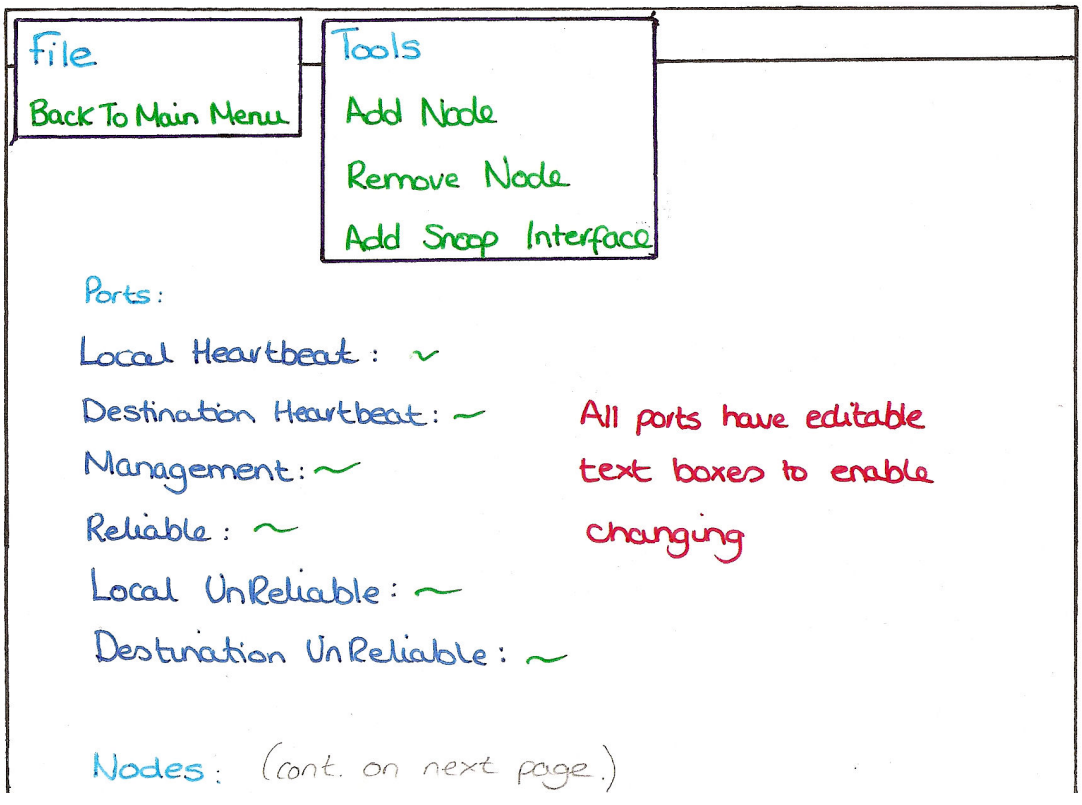
Appendix I: Final GUI Design

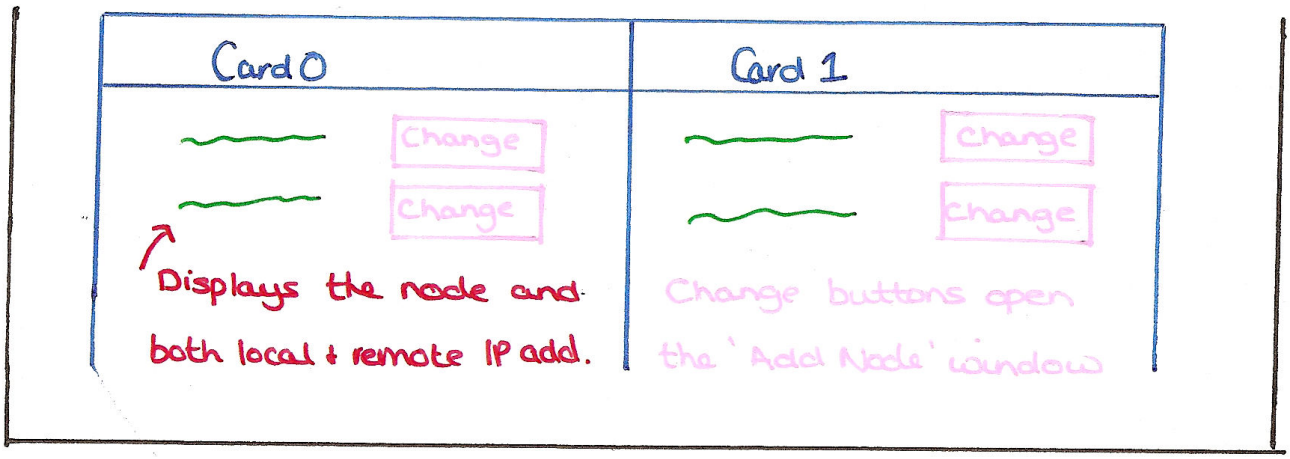
GUI Design Adapted



A sample Configure Interface Window (DTS)

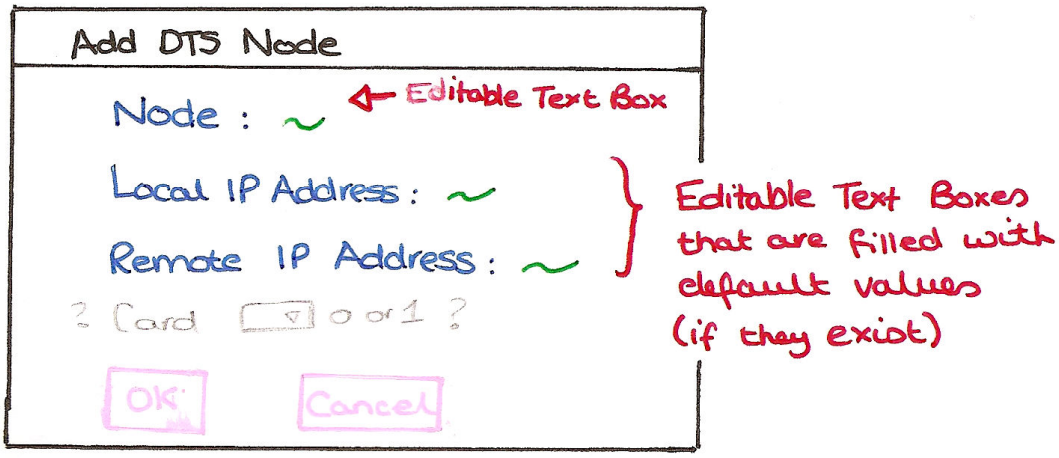
Popup Window





Popup Window

Add Node



Remove Specific Node — As Before

Change IP Address not needed anymore as they can be edited in the 'Add Node' window.

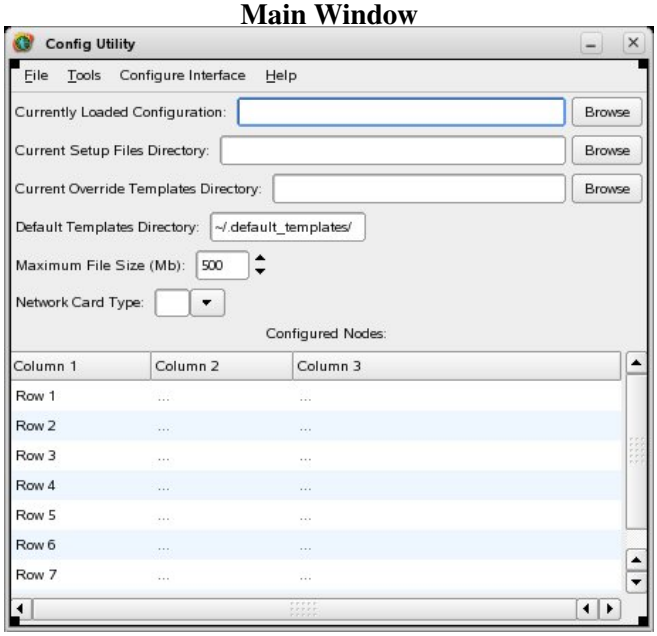
Windows on Fourth page of original design no longer needed.

→ Except 'Load Previous' which has no changes.

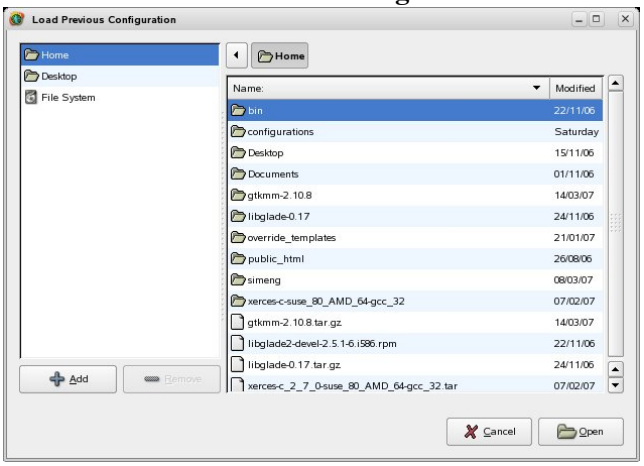
Appendix J: Glade Windows

The following screen shots show some of the windows produced using Glade.

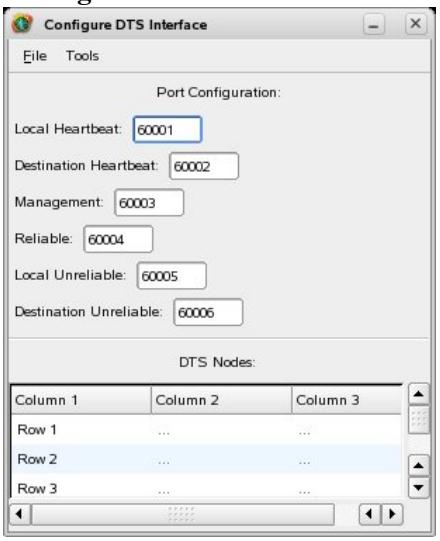
Main Window



Load Previous Configuration



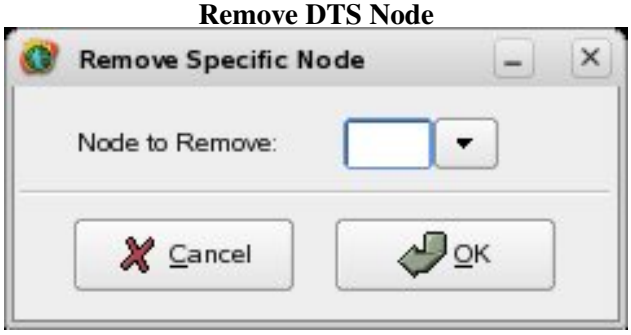
Configure DTS Interface Window



Add DTS Node

Add Snoop Node

Remove DTS Node



Appendix K: GUI Problems

The following document contains all evidence of the problems I had with coding the GUI.

The following emails were sent and received at the time when I was having problems with the GUI code.

From : ***
Sent : 25 January 2007 18:24:47
To : <springphoenix@hotmail.com>
Subject : FW: more GUI help!

-----Original Message-----
From: Rajaratnam, Kiran (UK)
Sent: 25 January 2007 18:24
To: 'Poole, Jennifer (UK)'
Cc: Lyons, Dominic (UK)
Subject: RE: more GUI help!

Are you calling the following 2 procedures:
Gtk_init - sets up default colours, initialises the libraries and sets up default signal handlers
Gtk_main - when the app hits this it waits for any triggers from the user.

If you are not calling the above 2 you need to be since they are compulsory.

Hope this helps,

Kiran

****
This email and any attachments are confidential to the intended recipient and may also be privileged. If you are not the intended recipient please delete it from your system and notify the sender. You should not copy it or use it for any purpose nor disclose or distribute its contents to any other person.
****

From : Gmane Autoauthorizer <auth@gmane.org>
Sent : 31 January 2007 20:41:40
To : springphoenix@hotmail.com
Subject : Re: Authorization required to post to gmane.comp.gnome.glade.user (82077a079ba86882f978e090a26d2907)

You are now authorized to post to the gmane.comp.gnome.glade.user newsgroup.

The original message you sent to the newsgroup will be posted within ten minutes.

If you have any questions, they are most likely answered in the FAQ: <URL: http://gmane.org/faq.php>.

--
Your friendly autoauthorizer at Gmane.org
http://gmane.org/

From: Jennifer <springphoenix@hotmail.com>
To: Glade-users@lists.ximian.com
Subject: Re: libglade2 and glade_xml_signal_autoconnect
Sent: 31 January 2007 20:39:26
David Hampton <hampton <at> employees.org> writes:

>
> On Mon, 2002-05-06 at 09:40, Damon Chaplin wrote:
> > On Mon, 2002-05-06 at 01:23, David Hampton wrote:
> > > Does glade_xml_signal_autoconnect work in glade2/gnome2? I'm
trying to
> > > use this in a program and keep getting warnings like this one:
> > >
> > >   (arq:31685): libglade-WARNING **: could not find
> > >   signal handler 'on_open_button_clicked'.
> > >
> > > I've traced this code through gmodule, glib, and the dl code and
> > > everything seems to be functioning properly, only the symbols for
the
> > > main program are never found. I see lots of other symbol being
compared
> > > to in the dl code, but it never finds my symbol.
> >
> > I think you need to add '-export-dynamic' to your linker options,
so
> > libglade can find the symbols in your code.
>
> You were right. I looked at the differences between the outputs of
the
> libglade-config and pkg-config programs. libglade-config puts out an
> argument of '-rdyamic' which is missing from the output of pkg-
config.
> (Missing for both libglade and libglade-2.0.) If I add this one
argument
> to my command line, I can successfully use
glade_xml_signal_autoconnect
> in glade2/gnome2.
>
> David
>
>

I am having a very similar problem to this, I added -rdynamic to my
makefile
but it hasn't helped. Is there anything else anyone can suggest that I
may have
forgotten/missed out?! I am compiling using `pkg-config gtk+2.0
libglade-2.0 --
libs`.

I have used extern "C" around my callback functions in my callbacks.cpp file
but still getting the errors

libglade-WARNING **: could not find signal handler '***'

for all of my signals created in glade.

Thanks, Jen

From : William Luesley <***>
Sent : 07 February 2007 09:52:44
To : Jennifer Poole <springphoenix@hotmail.com>
Subject : RE: GUI help!

Jen,

Sorry for not replying sooner, but I've been off on holiday, and not checking my mail.

As you mentioned the deadline was last week, don't know if you still need the help, but if you do, here are some possible solutions.

1) you need to allow libglade to see the callbacks defined in your main program, you do this by specifying --export-dynamic during the link stage.
2) if compiling a c++ program, the callbacks must have demangled names, you do this by wrapping the callbacks in a extern "C" block:

```
extern "C"
{
   void callback_one()
   {

   }
}
```

Hope all is going well for you,

Will.

From: Jennifer Poole [mailto:springphoenix@hotmail.com]
Sent: 31 January 2007 15:23
To: William Luesley
Subject: RE: GUI help!

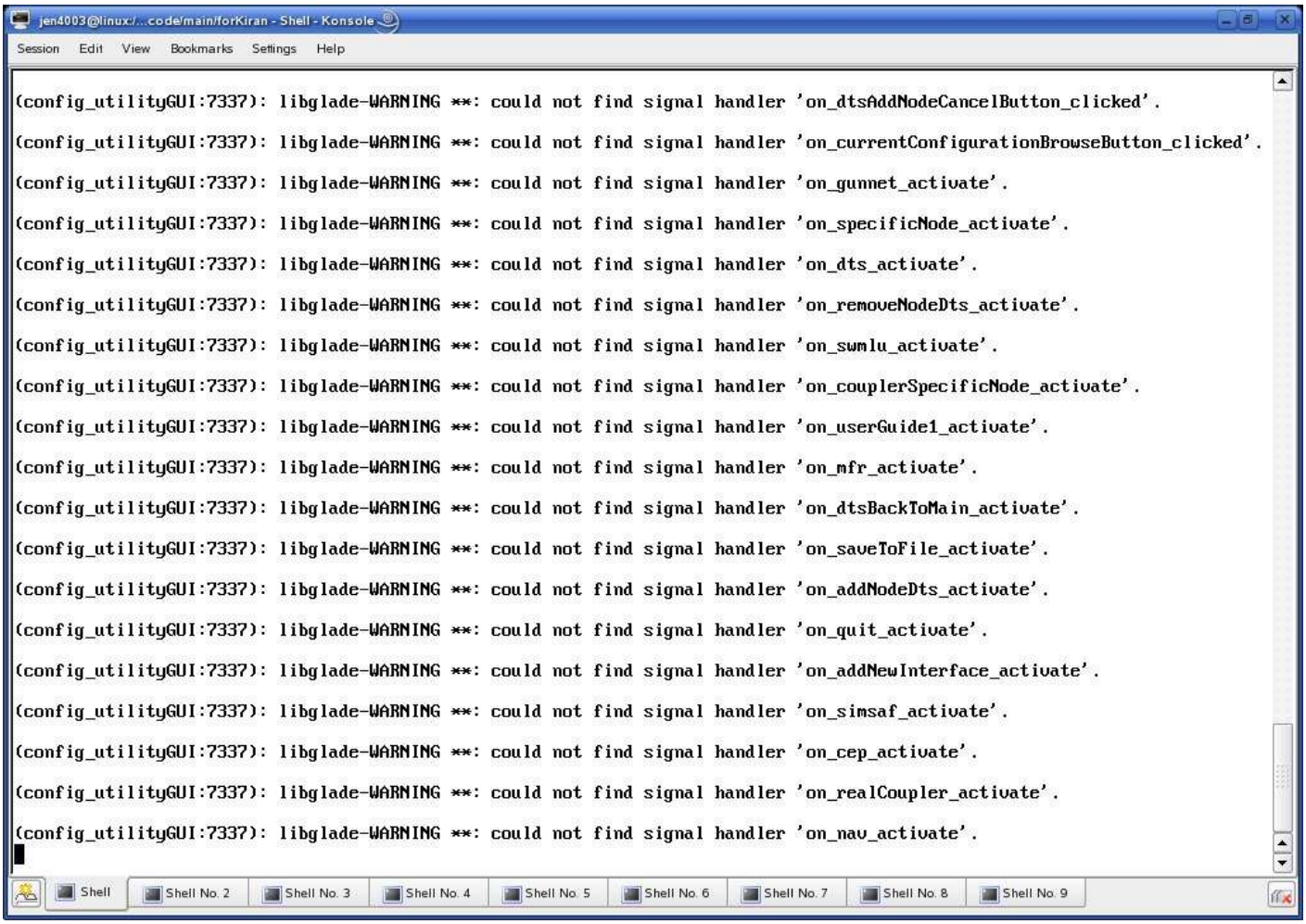
Hey Will hows things?
Im having a bit of trouble with my GUI (still lol). I am using glade_xml_signal_autoconnect() and passing it my glade xml file to link in my signals.
However when I run my program and it gets to this point, I get errors for all my signals saying could not find signal handler.
I have been tryin to find out whats wrong for a while now, I found quite a few other people who have also had this problem but can't

```
find a solution.
There was a suggestion that adding -rdynamic to the makefile would
help but it hasn't, can you help? Im getting really desperate now
because I gotta get the GUI all done by tomorrow!!
Thanks :) Jen xxx
```

The following is the original code I used to load in the glade file and connect the signals:

```
#include <glade/glade.h>
#include <string>
#include "gui.h"

GUI::GUI()
{
}

GUI::~GUI()
{
}

bool GUI::loadGui(string filename, int argc, char **argv)
{
    bool xmlLoaded = false;
    GladeXML *xml;

    //initialise gtk and glade
    gtk_init(&argc, &argv);
    glade_init();
    glade_gnome_init();

    //try to load the interface
    xml = glade_xml_new(filename.c_str(),NULL,NULL);

    //check the load worked
    if(xml!=0)
    {
        //connect any signals in the interface
        glade_xml_signal_autoconnect(xml);

        xmlLoaded = true;
    }

    return xmlLoaded;
}
```

Here is a screen shot of the warnings/errors that were displayed when I ran the program:


jen4003@linux:/...code/main/forKiran - Shell - Konsole
Session Edit View Bookmarks Settings Help
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_dtsAddNodeCancelButton_clicked'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_currentConfigurationBrowseButton_clicked'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_gunnet_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_specificNode_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_dts_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_removeNodeDts_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_swmlu_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_couplerSpecificNode_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_userGuide1_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_mfr_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_dtsBackToMain_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_saveToFile_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_addNodeDts_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_quit_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_addNewInterface_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_simsaf_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_cep_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_realCoupler_activate'.
(config_utilityGUI:7337): libglade-WARNING **: could not find signal handler 'on_nav_activate'.
Shell
Shell No. 2
Shell No. 3
Shell No. 4
Shell No. 5
Shell No. 6
Shell No. 7
Shell No. 8
Shell No. 9

The following code shows how I attempted to connect a signal manually after the previous code failed. The method connectSignals was called from the gui class after the glade xml file had been read in:

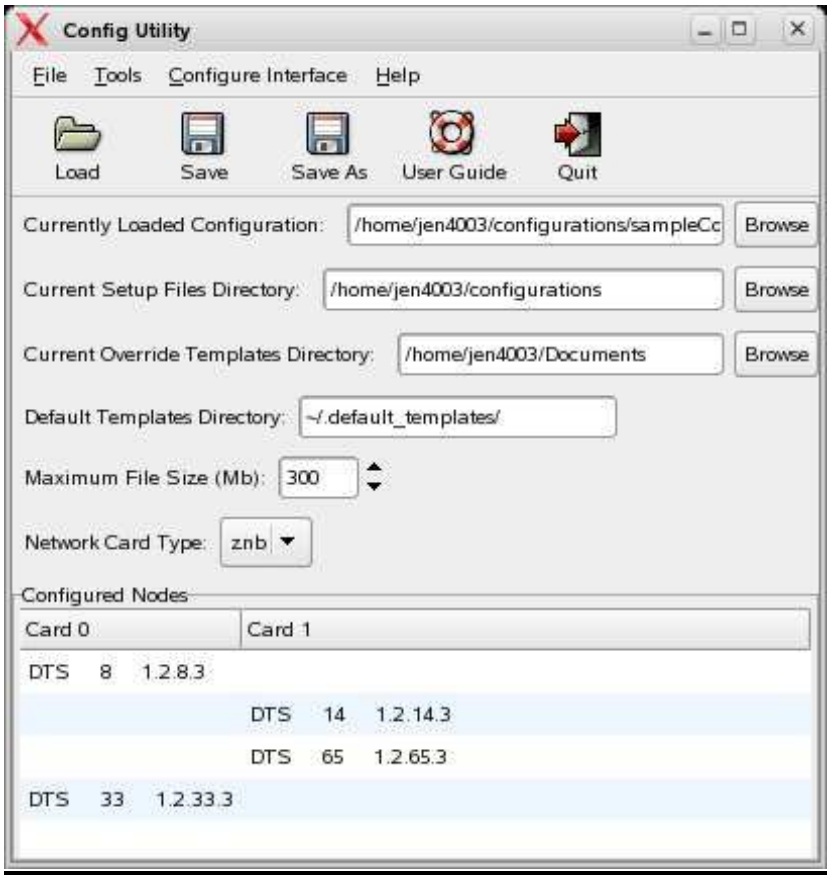
```
#include <string>
#include "callbacks.h"
#include <iostream>

extern GUI gui;

//GladeXML library neds the callbacks to have demangled names
extern "C"
{
     //method to connect signals to widgets
     void Callbacks::connectSignals(GladeXML *xml)
     {
```

```
        //obtain widget to connect signal to
        GtkWidget *currentConfigBrowse = glade_xml_get_widget(xml,
                              "currentConfigurationBrowseButton");

        //connect signal to button
        gtk_signal_connect(GTK_OBJECT(currentConfigBrowse), "clicked",
           GTK_SIGNAL_FUNC(on_currentConfigurationBrowseButton_clicked
                            ),NULL);
    }

...
}
```

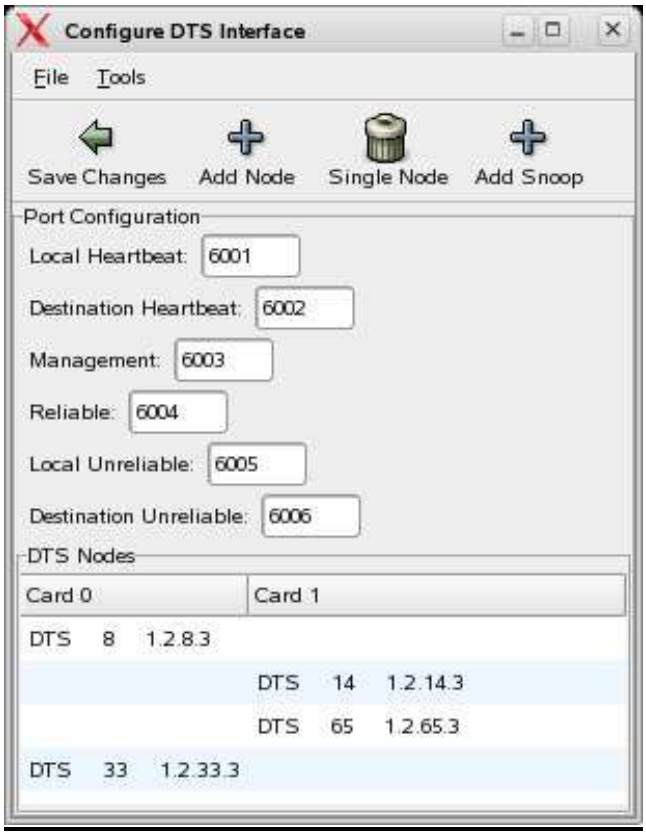
Appendix L: Screen Shots of Program

The following screen shots are of the GUI produced using the gtkmm library. The first set show the GUI before a change was made to the way the information was displayed in the tables.

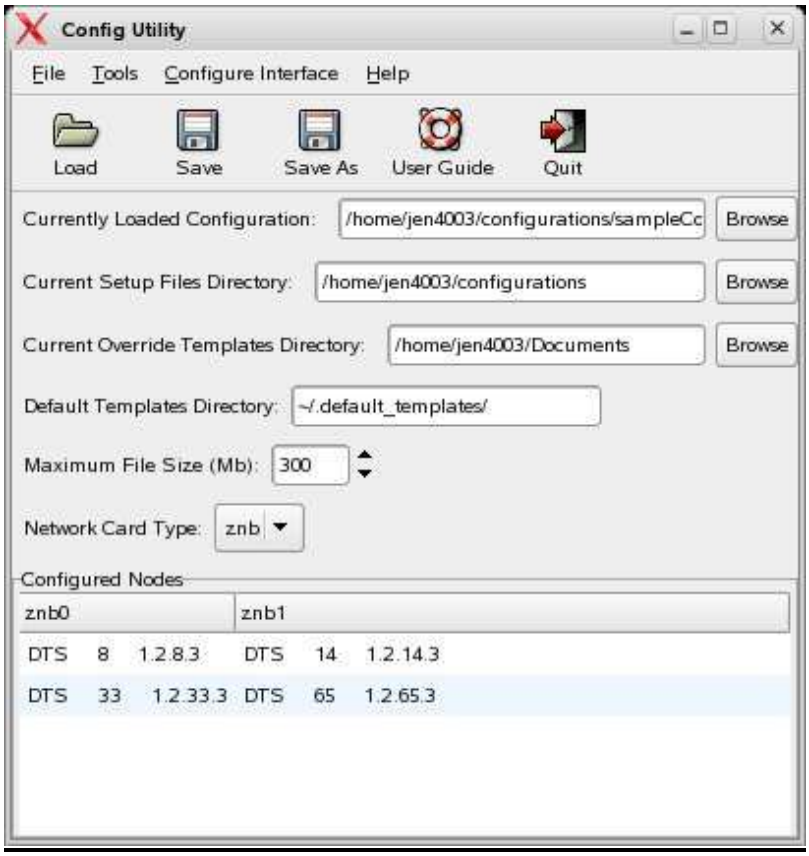
First GUI - Main Menu

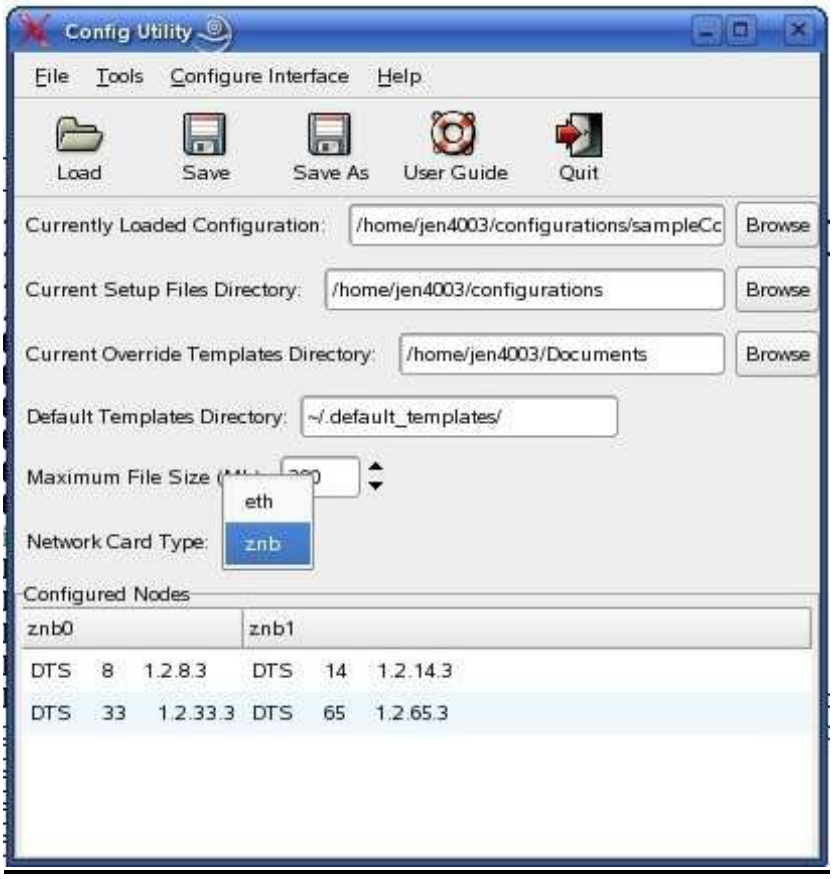

Config Utility
File Tools Configure Interface Help
Load Save Save As User Guide Quit
Currently Loaded Configuration: /home/jen4003/configurations/sampleCc Browse
Current Setup Files Directory: /home/jen4003/configurations Browse
Current Override Templates Directory: /home/jen4003/Documents Browse
Default Templates Directory: ~/.default_templates/
Maximum File Size (Mb): 300
Network Card Type: znb
Configured Nodes
Card 0 Card 1
DTS 8 1.2.8.3
DTS 14 1.2.14.3
DTS 65 1.2.65.3
DTS 33 1.2.33.3

Configure DTS Interface

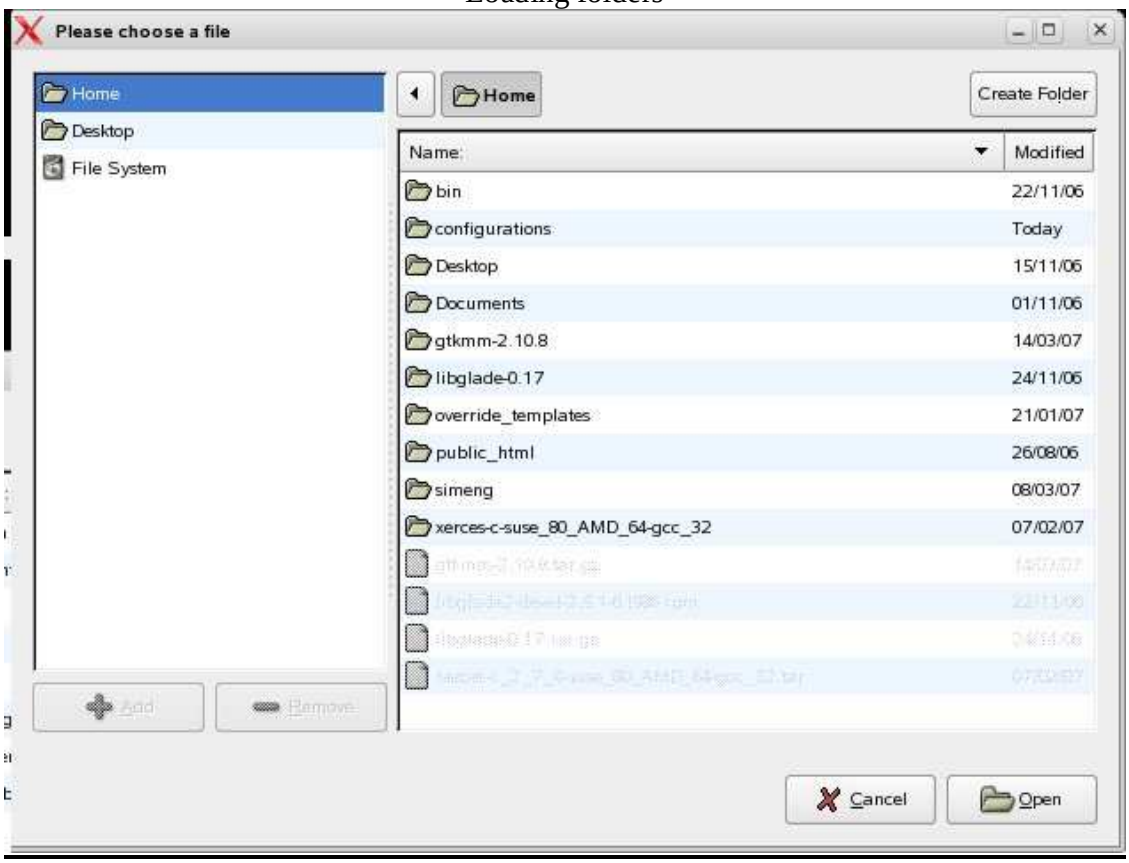


Second GUI – Main Window, Menu Items and Functions

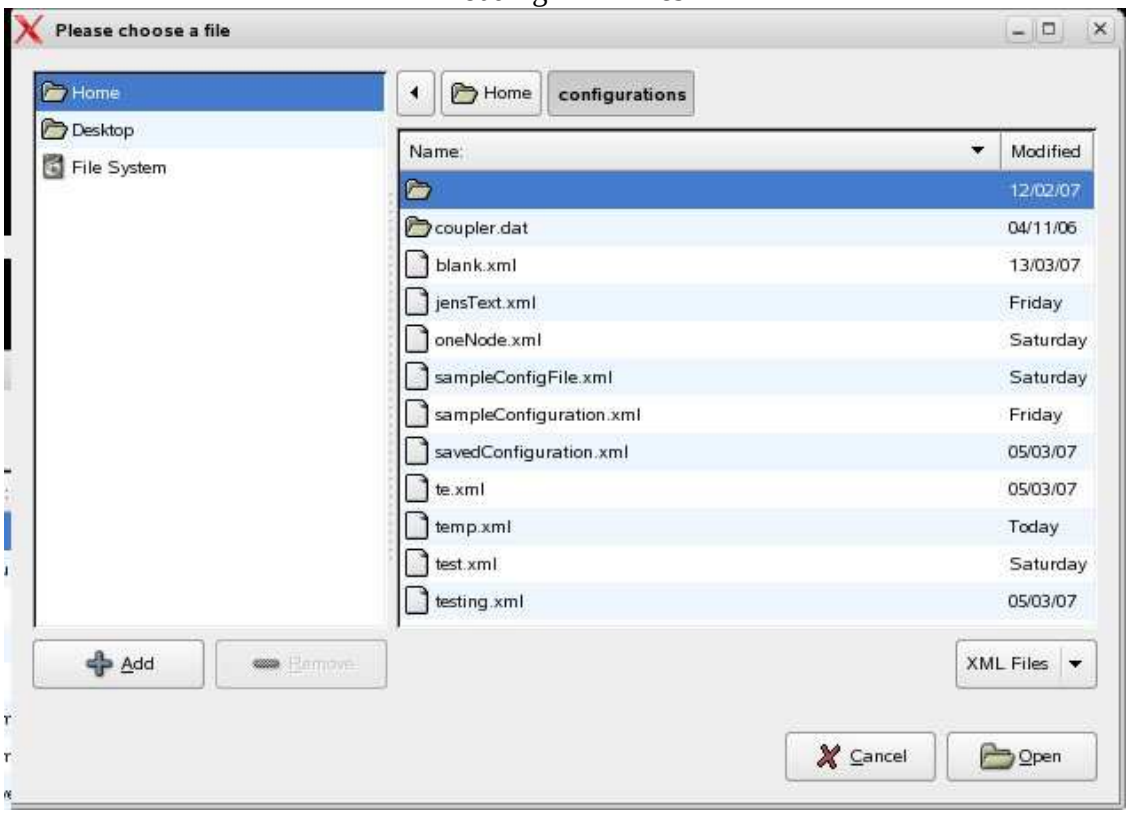

Config Utility
File Tools Configure Interface Help
Load Save Save As User Guide Quit
Currently Loaded Configuration: /home/jen4003/configurations/sampleCc Browse
Current Setup Files Directory: /home/jen4003/configurations Browse
Current Override Templates Directory: /home/jen4003/Documents Browse
Default Templates Directory: ~/.default_templates/
Maximum File Size (Mb): 300
Network Card Type: znb
Configured Nodes
znb0 znb1
DTS 8 1.2.8.3 DTS 14 1.2.14.3
DTS 33 1.2.33.3 DTS 65 1.2.65.3


Config Utility
File Tools Configure Interface Help
Load Save Save As User Guide Quit
Currently Loaded Configuration: /home/jen4003/configurations/sampleCc Browse
Current Setup Files Directory: /home/jen4003/configurations Browse
Current Override Templates Directory: /home/jen4003/Documents Browse
Default Templates Directory: ~/.default_templates/
eth
Network Card Type: znb
Configured Nodes
znb0 znb1
DTS 8 1.2.8.3 DTS 14 1.2.14.3
DTS 33 1.2.33.3 DTS 65 1.2.65.3

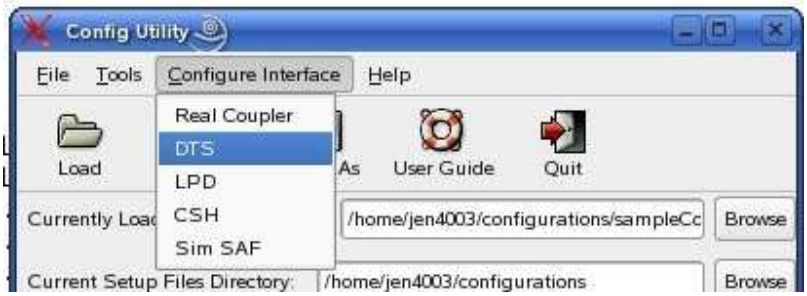
Loading folders



Loading XML files



Config Utility
File
Tools
Configure Interface
Help
Load Ctrl+O
Save Ctrl+S
Quit Ctrl+Q
Save As Ctrl+S
Save Ctrl+S
Browse


Config Utility
File
Tools
Configure Interface
Help
Real Coupler
DTS
LPD
CSH
Sim SAF
Load
User Guide
Quit
Currently Loac
/home/jen4003/configurations/sampleCc
Browse
Current Setup Files Directory:
/home/jen4003/configurations
Browse

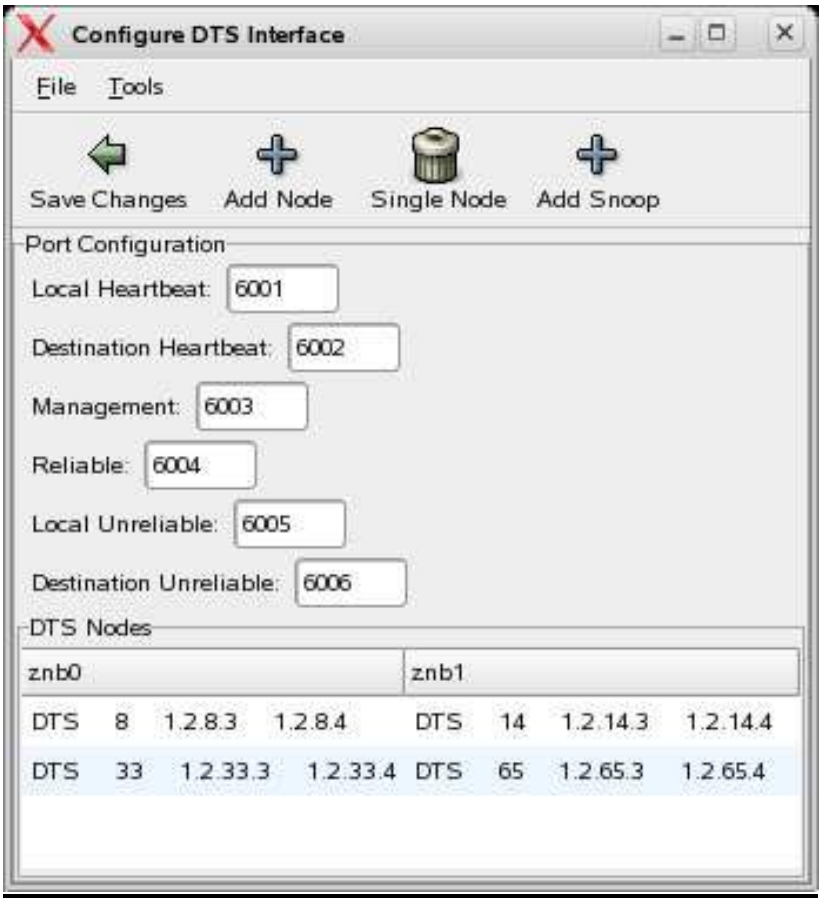
Config Utility
File
Tools
Configure Interface
Help
About
User Guide Ctrl+H
Load
Save

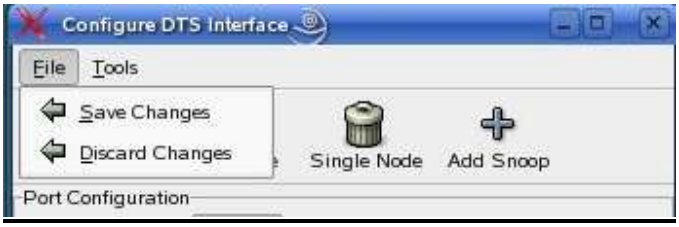
Information
This configuration hasn't been saved
Do you really want to quit?
OK
Cancel

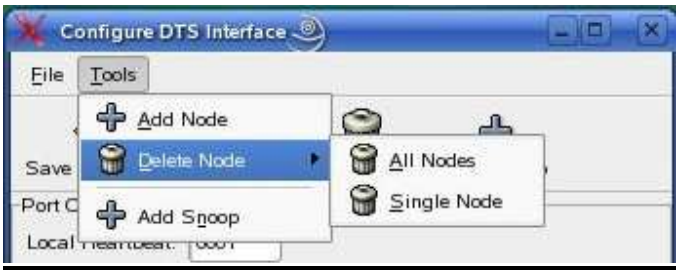
Information
File saved successfully
OK

Information <2>
Please reboot your computer
OK

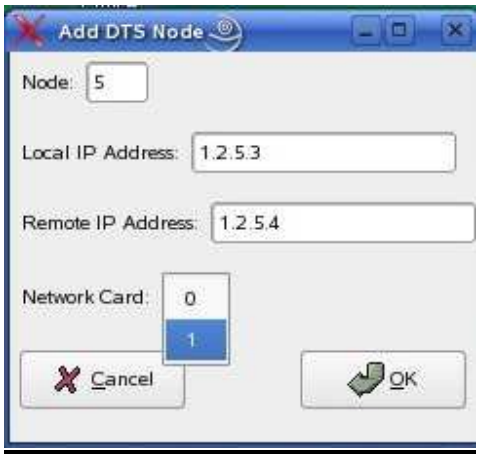
Configure DTS Interface Window, Menu Items and Functions





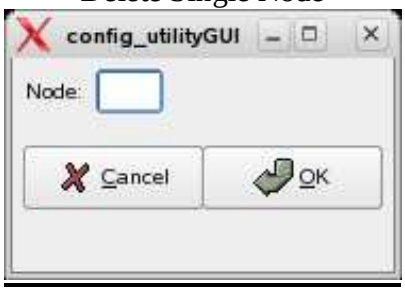


Add DTS Node



Add Snoop Node

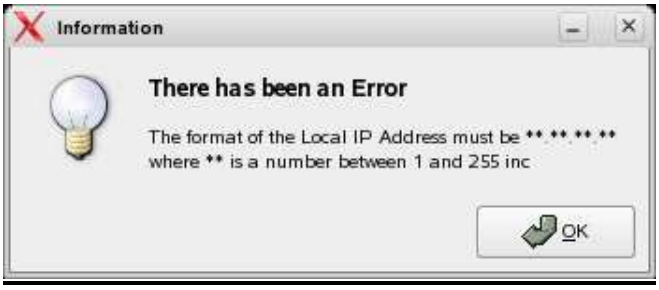
Delete Single Node

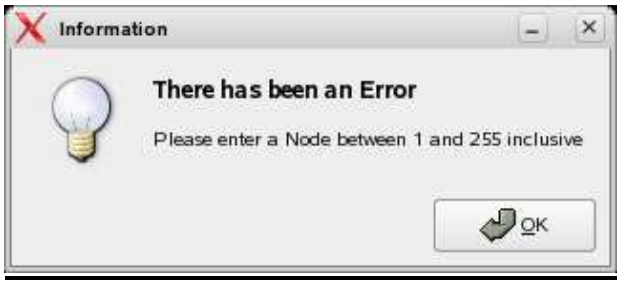


Delete All Nodes

Information
Are you sure you want to permenantly remove ALL nodes?
Note: This will remove all DTS nodes, including Snoop
OK
Cancel

Configure DTS Interface – Error Messages





Appendix M: Phase I Test Schedule

Test Step	**Expected Outcome**	**Outcome**
Main Window		
Start up program	Window should open displaying: **Currently Loaded Configuration** as: ***/home/jen4003/configurations/sampleConfigFile.xml*** **Current Setup File Directory** as: ***/home/jen4003/simeng/*** **Current Override Templates Directory** as ***/hom/.jen4003/override_templates/*** all with a browse button to the right **Default Templates Directory** as ***~/default_templates/*** **Maximum File Size (Mb)** as ***300*** displayed within a scroll button that has a minimum of 100 and max of 1700 **Network Card Type** as ***eth*** displayed in a combo box with the options eth and znb A table called **Configured Nodes** which has two columns, eth0 and eth1, but nothing under each column	As expected
Press 1st Browse Button	A file selection dialog is displayed, with title ***Please chose a file***. Files and folders can be selected	As expected
Press Cancel Button	Dialog closes, no changes to the main window	As expected
Press 2nd Browse Button	A file selection dialog is displayed, with title ***Please chose a file***. Files and folders can be selected	As expected
Press Cancel Button	Dialog closes, no changes to the main window	As expected
Press 3rd Browse Button	A file selection dialog is displayed, with title ***Please chose a file***. Files and folders can be selected	As expected
Press Cancel Button	Dialog closes, no changes to the main window	As expected
Press 1st Browse Button and select a non xml file	Error Message appears informing you that only xml files can be opened	Failed – Program crashes
Press OK and select *oneNode.xml*	Dialog closes and **Currently Loaded Configuration** changes to ***/home/jen4003/configurations/oneNode.xml*** **Configured Nodes** now has ***DTS 1.2.8.3*** in the eth0 column	As expected
Press 2nd Browse Button and select */home/jen4003/configurations/*	The dialog closes and **Current Setup File Directory** changes to ***/home/jen4003/configurations/***	Failed – can't select a folder, only a file
Press 3rd Browse Button and select */home/jen4003/templates/*	The dialog closes and **Current Override Templates Directory** changes to ***/home/jen4003/templates/***	Failed – can't select a folder, only a file
Change the Network Card Type to znb	The column titles change to ***znb0*** and ***znb1***	As expected
Press the Save Button	A message appears saying that the file has been saved ok	As expected
Press the Quit Button	A message appears telling you to reboot the computer	As expected
Start the program	Window should open displaying: **Currently Loaded Configuration** as: ***/home/jen4003/configurations/sampleConfigFile.xml*** **Current Setup File Directory** as: ***/home/jen4003/configurations/*** **Current Override Templates Directory** as ***/home/jen4003/templates/*** all with a browse button to the right **Default Templates Directory** as ***~/default_templates/***	Failed – no nodes

	Maximum File Size (Mb) as ***300*** displayed within a scroll button that has a minimum of 100 and max of 1700 **Network Card Type** as ***znb*** displayed in a combo box with the options eth and znb A table called **Configured Nodes** which has two columns, znb0 and znb1, with ***DTS 8 1.2.8.3*** under the znb0 column	

ABORTED

Appendix N: Phase II Test Schedule

Test Step	Expected Outcome	Outcome
Main Window		
Start up program	Window should open displaying: **Currently Loaded Configuration** as: ***/home/jen4003/configurations/sampleConfigFile.xml*** **Current Setup File Directory** as: ***/home/jen4003/simeng/*** **Current Override Templates Directory** as ***/hom/.jen4003/override_templates/*** all with a browse button to the right **Default Templates Directory** as ***~/default_templates/*** **Maximum File Size (Mb)** as ***300*** displayed within a scroll button that has a minimum of 100 and max of 1700 **Network Card Type** as ***eth*** displayed in a combo box with the options eth and znb A table called **Configured Nodes** which has two columns, eth0 and eth1, but nothing under each column	As expected
Press 1st Browse Button	A file selection dialog is displayed, with title ***Please chose a file***. Files and folders can be selected	As expected
Press Cancel Button	Dialog closes, no changes to the main window	As expected
Press 2nd Browse Button	A file selection dialog is displayed, with title ***Please chose a file***. Files and folders can be selected	As expected
Press Cancel Button	Dialog closes, no changes to the main window	As expected
Press 3rd Browse Button	A file selection dialog is displayed, with title ***Please chose a file***. Files and folders can be selected	As expected
Press Cancel Button	Dialog closes, no changes to the main window	As expected
Press 1st Browse Button and select a non xml file	Error Message appears informing you that only xml files can be opened	XML files can't be selected. OK
Press OK and select *oneNode.xml*	Dialog closes and **Currently Loaded Configuration** changes to ***/home/jen4003/configurations/oneNode.xml*** **Configured Nodes** now has ***DTS 1.2.8.3*** in the eth0 column	As expected
Press 2nd Browse Button and select */home/jen4003/configurations/*	The dialog closes and **Current Setup File Directory** changes to ***/home/jen4003/configurations/***	As expected
Press 3rd Browse Button and select */home/jen4003/templates/*	The dialog closes and **Current Override Templates Directory** changes to ***/home/jen4003/templates/***	As expected
Change the Network Card Type to znb	The column titles change to ***znb0*** and ***znb1***	As expected
Press the Save Button	A message appears saying that the file has been saved ok	As expected
Press the Quit Button	A message appears telling you to reboot the computer	As expected
Start the program	Window should open displaying: **Currently Loaded Configuration** as: ***/home/jen4003/configurations/sampleConfigFile.xml***	As expected

	Current Setup File Directory as: ***/home/jen4003/configurations/***	Failed – default displayed
	Current Override Templates Directory as ***/home/jen4003/templates/*** all with a browse button to the right	Failed – default displayed
	Default Templates Directory as ***~/default_templates/***	As expected
	Maximum File Size (Mb) as ***300*** displayed within a scroll button that has a minimum of 100 and max of 1700	As expected
	Network Card Type as ***znb*** displayed in a combo box with the options eth and znb	Failed – eth selected
	A table called **Configured Nodes** which has two columns, znb0 and znb1, with ***DTS 8 1.2.8.3*** under the znb0 column	As expected apart from eth instead of znb
Press Save As	A file selection dialog will be displayed	As expected
Change to configurations directory	Dialog displays files saved in configurations directory	Already in directory
Enter *test.xml*	Dialog closes and **Currently Loaded Configuration** changes to ***/home/jen4003/configurations/text.xml***	As expected
Configure DTS Interface Window		For the purpose of the rest of the test, I changed Network Card to znb
Select Configure Interface ->DTS	Another window opens with title ***Configure DTS Interface*** The following is displayed:	
	Ports: **Local Heartbeat:** ***60001*** **Destination Heartbeat:** ***60002*** **Management:** ***60003*** **Reliable:** ***60004*** **Local Unreliable:** ***60005*** **Destination Unreliable:** ***60006***	As expected
	A table called **DTS Nodes** which has two columns, znb0 and znb1, with ***DTS 8 1.2.8.3 1.2.8.4*** under the znb0 column	As expected
Press the Add Node Button	An Add Node dialog appears	As expected
In the Node Id field, type 19 and press enter	The Node Id entry displays ***19*** The Local IP Address displays ***1.2.19.3*** The Remote IP Address displays ***1.2.19.4***	As expected
In the Network Card Combo box, select 1	The Network Card Combo box displays ***1***	As expected
Press the OK button	The table is updated and under the znb1 column ***DTS 19 1.2.19.3 1.2.19.4*** is displayed	As expected
Press the discard changes menu item	The DTS Window closes and no changes are made to the main window	As expected
Change the network card to eth	The **Network Card Type** changes to eth, as do the column headers.	As expected
Select Configure Interface ->DTS	Another window opens with title ***Configure DTS Interface*** The following is displayed:	As expected
	Ports:	

	Local Heartbeat: ***60001*** **Destination Heartbeat:** ***60002*** **Management:** ***60003*** **Reliable:** ***60004*** **Local Unreliable:** ***60005*** **Destination Unreliable:** ***60006*** A table called **DTS Nodes** which has two columns, eth0 and eth1, with ***DTS 8 1.2.8.3 1.2.8.4*** under the eth0 column.	As expected Failed – also got node 19 which was added before.

ABORTED

Appendix O: Phase III Test Schedule

Test Step	Expected Outcome	Outcome
Main Window		
Start up program	Window should open displaying: **Currently Loaded Configuration** as: ***/home/jen4003/configurations/sampleConfigFile.xml*** **Current Setup File Directory** as: ***/home/jen4003/simeng/*** **Current Override Templates Directory** as ***/hom/.jen4003/override_templates/*** all with a browse button to the right **Default Templates Directory** as ***~/default_templates/*** **Maximum File Size (Mb)** as ***300*** displayed within a scroll button that has a minimum of 100 and max of 1700 **Network Card Type** as ***eth*** displayed in a combo box with the options eth and znb A table called **Configured Nodes** which has two columns, eth0 and eth1, but nothing under each column	As expected
Press 1st Browse Button	A file selection dialog is displayed, with title ***Please chose a file***. Files and folders can be selected	As expected
Press Cancel Button	Dialog closes, no changes to the main window	As expected
Press 2nd Browse Button	A file selection dialog is displayed, with title ***Please chose a file***. Files and folders can be selected	As expected
Press Cancel Button	Dialog closes, no changes to the main window	As expected
Press 3rd Browse Button	A file selection dialog is displayed, with title ***Please chose a file***. Files and folders can be selected	As expected
Press Cancel Button	Dialog closes, no changes to the main window	As expected
Press 1st Browse Button and select a non xml file	Error Message appears informing you that only xml files can be opened	As expected – can only select XML files
Press OK and select *oneNode.xml*	Dialog closes and **Currently Loaded Configuration** changes to ***/home/jen4003/configurations/oneNode.xml*** **Configured Nodes** now has ***DTS 1.2.8.3*** in the eth0 column	As expected
Press 2nd Browse Button and select */home/jen4003/configurations/*	The dialog closes and **Current Setup File Directory** changes to ***/home/jen4003/configurations/***	As expected
Press 3rd Browse Button and select */home/jen4003/templates/*	The dialog closes and **Current Override Templates Directory** changes to ***/home/jen4003/templates/***	As expected
Change the Network Card Type to znb	The column titles change to ***znb0*** and ***znb1***	As expected
Press the Save Button	A message appears saying that the file has been saved ok	As expected
Press the Quit Button	A message appears telling you to reboot the computer	As expected
Start the program	Window should open displaying: **Currently Loaded Configuration** as: ***/home/jen4003/configurations/sampleConfigFile.xml***	As expected

	Current Setup File Directory as: ***/home/jen4003/configurations/*** **Current Override Templates Directory** as ***/home/jen4003/templates/*** all with a browse button to the right **Default Templates Directory** as ***~/default_templates/*** **Maximum File Size (Mb)** as ***300*** displayed within a scroll button that has a minimum of 100 and max of 1700 **Network Card Type** as ***znb*** displayed in a combo box with the options eth and znb A table called **Configured Nodes** which has two columns, znb0 and znb1, with ***DTS 8 1.2.8.3*** under the znb0 column	
Press Save As	A file selection dialog will be displayed	As expected
Change to configurations directory	Dialog displays files saved in configurations directory	As expected – already in directory
Enter *test.xml*	Dialog closes and **Currently Loaded Configuration** changes to ***/home/jen4003/configurations/text.xml***	As expected
Configure DTS Interface Window		
Select Configure Interface ->DTS	Another window opens with title ***Configure DTS Interface*** The following is displayed: **Ports:** **Local Heartbeat:** ***60001*** **Destination Heartbeat:** ***60002*** **Management:** ***60003*** **Reliable:** ***60004*** **Local Unreliable:** ***60005*** **Destination Unreliable:** ***60006*** A table called **DTS Nodes** which has two columns, znb0 and znb1, with ***DTS 8 1.2.8.3 1.2.8.4*** under the znb0 column	As expected
Press the Add Node Button	An Add Node dialog appears	As expected
In the Node Id field, type 19 and press enter	The Node Id entry displays ***19*** The Local IP Address displays ***1.2.19.3*** The Remote IP Address displays ***1.2.19.4***	As expected
In the Network Card Combo box, select 1	The Network Card Combo box displays ***1***	As expected
Press the OK button	The table is updated and under the znb1 column ***DTS 19 1.2.19.3 1.2.19.4*** is displayed	As expected
Press the discard changes menu item	The DTS Window closes and no changes are made to the main window	As expected
Change the network card to eth	The **Network Card Type** changes to eth, as do the column headers.	As expected
Select Configure Interface ->DTS	Another window opens with title ***Configure DTS Interface*** The following is displayed: **Ports:** **Local Heartbeat:** ***60001***	As expected

	Destination Heartbeat: ***60002*** **Management:** ***60003*** **Reliable:** ***60004*** **Local Unreliable:** ***60005*** **Destination Unreliable:** ***60006*** A table called **DTS Nodes** which has two columns, eth0 and eth1, with ***DTS 8 1.2.8.3 1.2.8.4*** under the eth0 column.	
Press the Add Snoop button	The Add Snoop dialog appears	As expected
In the node Id box, type 19 and press enter	The local IP Address field is filled in with ***1.2.19.3***	As expected
Press OK	The DTS Nodes table is updated and ***DTS 19 1.2.19.3 S*** appears under each column	As expected
Press the Save Changes Button	The DTS Window closes and the main window is updated so that in the **Configured Nodes** table, there is ***DTS 8 1.2.8.3*** and ***DTS 19 1.2.19.3 S*** under the eth0 column and ***DTS 19 1.2.19.3 S*** under the eth1 column	As expected
Select Configure Interface -> DTS	Another window opens with title ***Configure DTS Interface*** The following is displayed: **Ports:** **Local Heartbeat:** ***60001*** **Destination Heartbeat:** ***60002*** **Management:** ***60003*** **Reliable:** ***60004*** **Local Unreliable:** ***60005*** **Destination Unreliable:** ***60006*** A table called **DTS Nodes** which has two columns, eth0 and eth1, with ***DTS 8 1.2.8.3 1.2.8.4*** and ***DTS 19 1.2.19.3 S*** under the eth0 column and ***DTS 19 1.2.19.3 S*** under the eth1 column.	As expected
Validation		
Press the Add Node button	The Add Node dialog appears	As expected
In the node Id box, type 19 and press enter	The local IP Address field is filled in with ***1.2.19.3*** and the Remote IP Address field is filled with ***1.2.19.4***	As expected
Press the OK button	An error message appears asking you to **select a network**	As expected
Press OK Select 1 from the network combo box and press the OK button	The message box closes. The network card is set to 1 An error message appears telling you the **node already exists**	As expected As expected As expected
Press OK Change the node Id to 23 but don't press enter	The message box closes The node Id box changes to 23 but nothing else changes	As expected As expected
Press the OK button	An error message appears telling you the **Local IP Address Already Exists**	As expected
Press OK Change the Local IP Address to 24	The message box closes The Local IP Address field changes to 24	As expected As expected
Press the OK button	An error message appears telling you **The format of the Local IP Address must be **.**.**.** where ** is a number between 1 and 255 inc**	As expected
Press OK Change the Local IP Address to 255.255.255.255	The message box closes The Local IP Address field changed to 255.255.255.255	As expected
Press the OK button	An error message appears telling you **Local IP Address**	As expected

	is invalid	
Press OK Change the Local IP Address to 256.2.3.4	The message box closes The Local IP Address field changes to 256.2.3.4	As expected As expected
Press the OK button	An error message appears telling you **One of the terms of the Local IP Address is out of range (1->255 inc)**	As expected
Press OK Change the Local IP Address to 12.32.3.56	The message box closes The Local IP Address field changes to 12.32.3.56	As expected As expected
Press the OK button	An error message appears telling you **The third term of the Local IP Address must be the node Id (23)**	As expected
Press OK Change the Local IP Address to 12.32.23.56	The message box closes The Local IP Address field changes to 12.32.23.56	As expected As expected
Press the OK button	The DTS window updates and the **DTS Nodes** table changes so that ***DTS 8 1.2.8.3 1.2.8.4*** and ***DTS 19 1.2.19.3 S*** appears under the eth0 column and ***DTS 19 1.2.19.3 S*** and ***DTS 23 12.32.23.56 1.2.23.4*** appears under the eth1 column.	As expected
Deleting a node		
Press the Delete Single Node button	The Delete Single Node Dialog appears	As expected
In the Node Id field, type 8 Press the OK button	The Node Id field changes to 8 The DTS node 8 disappears from the **DTS Nodes** table so that now ***DTS 19 1.2.19.3 S*** appears under the eth0 column and ***DTS 19 1.2.19.3 S*** and ***DTS 23 12.32.3.56 1.2.23.4*** appears under the eth1 column.	As expected As expected
Press the Save Changes button	The DTS Window closes and the main window is updated so that in the **Configured Nodes** table, there is ***DTS 19 1.2.19.3 S*** under the eth0 column and ***DTS 19 1.2.19.3 S*** and ***DTS 23 12.32.3.56*** under the eth1 column.	As expected
Select Configure Interface -> DTS	Another window opens with title ***Configure DTS Interface*** The following is displayed: **Ports:** **Local Heartbeat:** ***60001*** **Destination Heartbeat:** ***60002*** **Management:** ***60003*** **Reliable:** ***60004*** **Local Unreliable:** ***60005*** **Destination Unreliable:** ***60006*** A table called **DTS Nodes** which has two columns, eth0 and eth1, with ***DTS 19 1.2.19.3 S*** under the eth0 column and ***DTS 19 1.2.19.3 S*** and ***DTS 23 12.32.3.56 1.2.23.4*** under the eth1 column.	As expected
Select Tools -> Delete Node -> All Nodes	An Information Message appears warning that all the nodes will be permanently removed, including Snoop nodes	As expected
Press Cancel	No changes are made to the DTS Window	As expected
Select Tools -> Delete Node -> All Nodes	An Information Message appears warning that all the nodes will be permanently removed, including Snoop nodes	As expected
Press the OK button	The DTS Window is updated an all the nodes in the **DTS Nodes** table disappear	As expected
Press the Save Changes	The DTS Window closes and the main window updates	As expected

Button	so that there are no nodes in the **Configured Nodes** table	
Loading a file		
Press the Load button	A file selection dialog is displayed, with title ***Please chose a file***.	As expected
Go to */home/jen4003/configurations/* and select the *text.xml* file	The file name changes to ***test.xml***	As expected
Press OK	The main window should update to: **Currently Loaded Configuration** as: ***/home/jen4003/configurations/test.xml*** **Current Setup File Directory** as: ***/home/jen4003/configurations/*** **Current Override Templates Directory** as ***/home/jen4003/templates/*** all with a browse button to the right **Default Templates Directory** as ***~/default_templates/*** **Maximum File Size (Mb)** as ***300*** displayed within a scroll button that has a minimum of 100 and max of 1700 **Network Card Type** as ***znb*** displayed in a combo box with the options eth and znb A table called **Configured Nodes** which has two columns, znb0 and znb1, with ***DTS 8 1.2.8.3*** under the znb0 column	As expected
Select Configure Interface -> DTS	Another window opens with title ***Configure DTS Interface*** The following is displayed: **Ports:** **Local Heartbeat:** ***60001*** **Destination Heartbeat:** ***60002*** **Management:** ***60003*** **Reliable:** ***60004*** **Local Unreliable:** ***60005*** **Destination Unreliable:** ***60006*** A table called **DTS Nodes** which has two columns, znb0 and znb1, with ***DTS 8 1.2.8.3 1.2.8.4*** under the znb0 column	As expected
Press the Add Node button	The Add Node dialog appears	As expected
Type 14 in the Node Id box and press enter	The Node Id field shows ***14***, the Local IP Address is filled in with ***1.2.14.3*** and the Remote IP Address is filled in with ***1.2.14.4***	As expected
Change the Network Card to 1	The Network Card changes to ***1***	As expected
Press the OK button	The DTS Window is updated and the **DTS Nodes** table now displays ***DTS 8 1.2.8.3 1.2.8.4*** under the znb0 column and ***DTS 14 1.2.14.3 1.2.14.4***	As expected – Node under znb 1 is in the row below node under znb0
Press the Save Changes Button	The DTS window closes and the main window is updated. The **Configured Nodes** table changes to display ***DTS 8 1.2.8.3*** under the znb0 column and ***DTS 14 1.2.14.3*** under the znb1 column	As expected
Press the Save Button	A message appears telling you the file has been saved successfully	As expected
Press the Quit button	A message appears telling you to reboot your computer	As expected

IP Aliasing		
Reboot the computer	Computer reboots	As expected
In a shell, type su and press enter, entering the password when prompted	Shell changes to super user mode	As expected
Type *ifconfig*	All the IP Addresses configured on the computer will appear. The following lines should appear: ***Znb0:0 inet addr 1.2.8.3 Bcast: 1.255.255.255 Mask: 255.255.255.0*** ***Znb1:0 inet addr 1.2.14.3 Bcast: 1.255.255.255 Mask: 255.255.255.0***	As expected
Start the Program	The main window should open to display: **Currently Loaded Configuration** as: ***/home/jen4003/configurations/sampleConfigFile.xml*** **Current Setup File Directory** as: ***/home/jen4003/configurations/*** **Current Override Templates Directory** as ***/home/jen4003/templates/*** all with a browse button to the right **Default Templates Directory** as ***~/default_templates/*** **Maximum File Size (Mb)** as ***300*** displayed within a scroll button that has a minimum of 100 and max of 1700 **Network Card Type** as ***znb*** displayed in a combo box with the options eth and znb A table called **Configured Nodes** which has two columns, znb0 and znb1, with ***DTS 8 1.2.8.3*** under the znb0 column and ***DTS 14 1.2.14.3*** under the znb1 column	As expected
Change the Network Card Type to eth	The Network card type changes to eth as do the column headers	As expected
Press the Save button	A message appears informing you that the file was saved successfully	As expected
Press the Quit button	A message appears telling you to reboot the computer	As expected
Reboot the computer	Computer reboots	As expected
In a shell, type su and press enter, entering the password when prompted	Shell changes to super user mode	As expected
Type *ifconfig*	All the IP Addresses configured on the computer will appear. The following lines should appear: ***Eth0:0 inet addr 1.2.8.3 Bcast: 1.255.255.255 Mask: 255.255.255.0*** ***Eth1:0 inet addr 1.2.14.3 Bcast: 1.255.255.255 Mask: 255.255.255.0***	As expected

Appendix P: GUI Feedback

The following feedback was obtained from the SAINTT team upon viewing the initial GUI design:

> There is probably enough room on the main window to display the current setup and currently configured nodes. Therefore, no view menu option is required.
> In the Tools menu option, the toggle network card, change setup files, change override templates file and change max file size options aren't needed. They can all be changed using browse buttons or via the spin buttons used to display the information. Therefore the only option needed in the tool menu is the Add New Interface (this will only be accessable if I have time to incorperate this option).
> When displaying the current setup information, there should be browse buttons connected to the first three. These should lead to a file selection dialog. The top one should default to where configurations are saved (currently ∼/configurations/). The Max File Size should be displayed via a spin button. This should be validated (limit to 100 → 1700). It is suggested to display the network card type in a drop down list containing eth and znb. This way the user can simply change it if they wish.
> In the configure interface windows, there is enough room to display the currently configured nodes and the ports. This means the view menu option is no longer required. In the display for currently configured nodes, display both the remote and local IP Addresses. It is an idea to allow the user to double click a node and allow them to change any information they may need. (ie take them to the add node window which should display the current

setup for the node selected).

Rather than have a seperate menu item for adding a node to card 0 and card 1, on the add node window, let the user choose which network card to add the node to.

Where the ports are displayed, make the display editable so that the user can change the numbers (as opposed to having a change button next to every port number).

In the Add node window, it is sensible to display any IP Addresses for that interface which, when the node id is entered, will be filled in with sensible defaults.

Appendix Q: User Guide

The following shows print screens of all the pages of the user guide. Since it was required that the user guide was web based for use on the company's intranet, the HTML can be accessed on the CD of deliverables. To get the home page, open the index.html file and all the links to the other pages will work from there.

Home

Starting the Program

Loading Existing Configurations

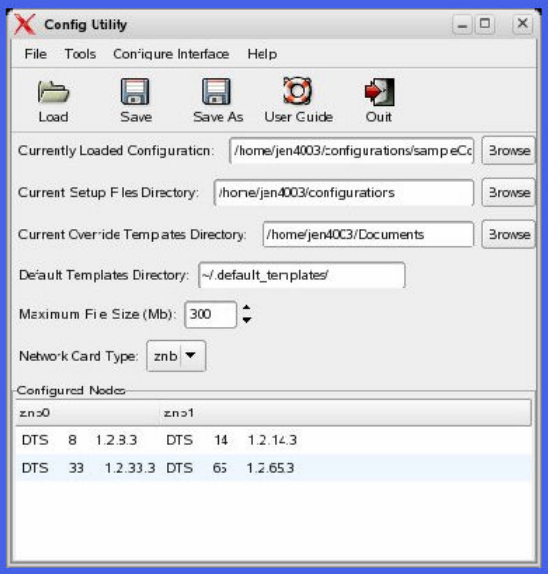
Saving Configurations

Changing Setup Fields

Configure Interfaces

Quitting the Program

User Guide for the Config Utility



Home

Starting the Program

Loading Existing Configurations

Saving Configurations

Changing Setup Fields

Configure Interfaces

Quitting the Program

Starting the Program

To start the Configuration Utility, press the 'Config Utility' button on your desktop.

The program will load up and will read in the configuration file 'SampleConfigFile.xml' which is located in the ~/configurations/ directory.

Upon loading the config file, the program will check the file against a schema. If any errors are found, you will be alerted. Default values will be used for the setup fields and no nodes will be configured.

Assuming no errors are found, the Config Utility will display the currently loaded configuration (which will be ~/configurations/SampleConfigFile.xml) and will fill the other setup fields in with the information written in the config file.

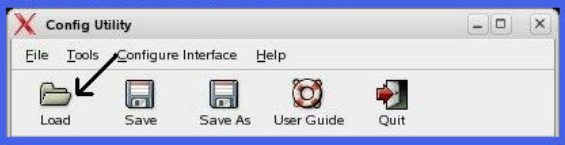
At the bottom of the screen, there will be a table containing details of all the nodes currently configured and the interfaces they are configured on.

Home
Starting the Program
Loading Existing Configurations
Saving Configurations
Changing Setup Fields
Configure Interfaces
Quitting the Program

Loading Existing Configurations

The Config Utility allows you to load an existing configuration file. This file must be an XML file and it must be in the correct format (as described in the schema).

There are three ways to load a config file.
1) Press the Load button on the Toolbar



2) Select File -> Load from the Menu

3) Press the browse button to the right of the 'Currently Loaded Configuration' field.

You will be displayed a file selection dialog. Navigate to the required directory and select the config file you wish to load.

If there are any errors with your file, the program will display an error message and no changes will be made to the Config Utility screen. The current setup will not change.

If the load was successful, the Config Utility will update to display the information in the loaded config file. The Currently Loaded Configuration will change to display the path and filename you selected.

Home

Starting the Program

Loading Existing Configurations

Saving Configurations

Changing Setup Fields

Configure Interfaces

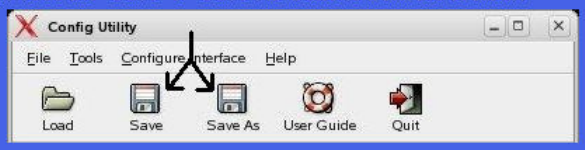
Quitting the Program

Saving Configurations

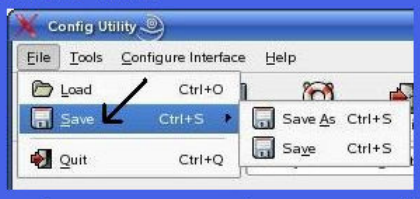
There are two different ways to save your configuration; overwrite the configuration currently open or save to a new name.

No matter which way you save your configuration, the SampleConfigFile.xml will be overwritten with the configuration you are saving. Due to this, if you wish to save a configuration for use at a later time, you must select the 'Save As' option.

There are two ways to either 'Save' or 'Save As':
1) Press the 'Save' or 'Save As' buttons from the toolbar.



2) Select the File -> Save menu item and select the type of save you wish to make.



If you chose to save to another name, you will be presented a file selection dialog which allows you to navigate to the required directory and either select a file to overwrite or enter the new name you wish the file to have. Note: You will be asked before overwriting an existing file.

If you chose to just save, an information dialog will be presented, informing you that the save was successful.
If you try to quit the program before saving, you will be told that you haven't saved the configuration and asked if you really want to quit.

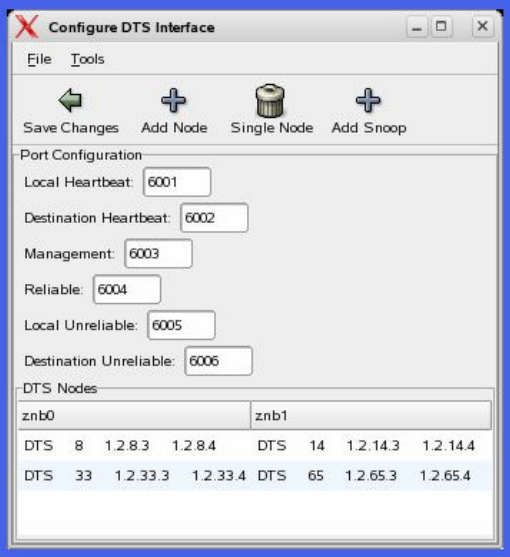
Home
Starting the Program
Loading Existing Configurations
Saving Configurations
Changing Setup Fields
Configure Interfaces
- Adding a Node
- Adding a Snoop Node
- Deleting Single Nodes
- Deleting All Nodes
- Saving/Discarding Changes
- Errors

Quitting the Program

Configure Interfaces

The Configure Interface Menu Item gives you a list of all the Interfaces that you can configure nodes for. Since most of the interfaces follow the same idea but with some different fields, this section will guide you on how to set up a DTS node.

When selecting Configure Interface -> DTS, you will be presented with a new window as seen below.



As can be seen, the various Ports available for this Interface are displayed. These values will be loaded from the configuration file, or, if no Port values are set within the configuration, default values will be used. These values can be changed although the new values will be validated before it is accepted. No two Port numbers for one interface may be the same. If you happen to enter a Port number that already exists, you will be prompted to change the existing number.

Underneath the Port numbers, you will see a table like the one displayed on the main window. This table will display all the nodes currently configured on the Interface (DTS in this case). This table will show a bit more detail than the one on the main window. Note, the DTS interface will also display any Snoop nodes configured.

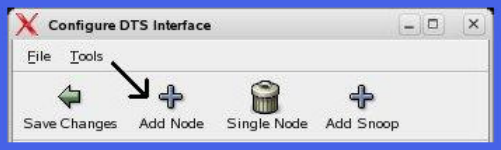
These values can be edited or deleted and new nodes can be added.

Home
Starting the Program
Loading Existing Configurations
Saving Configurations
Changing Setup Fields
Configure Interfaces
Adding a Node
Adding a Snoop Node
Deleting Single Nodes
Deleting All Nodes
Saving/Discarding Changes
Errors
Quitting the Program

Adding a Node

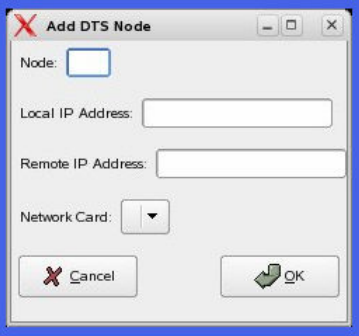
This section details how to add a node. Since the principle is the same for all interfaces, this User Guide will step you through the DTS Interface.

There are two ways to add a node to your interface.
1) Press the Add Node button on the tool bar



2) Select Tools -> Add Node from the menu

You will be displayed an 'Add DTS Node' dialog:



In the Node entry, type the Node Id of the node you wish to add. If you wish to use the default IP Address values for that node, simply press the enter key and the program will automatically fill in the Local and Remote IP Address fields. You are able to change these values as long as they are valid. Finally select the Network Card you wish to add the node to and press the OK button.

If you enter an invalid value in any of the fields, an error message will appear informing you of the mistake. By acknowledging the error you are able to change the value and press the OK button again.

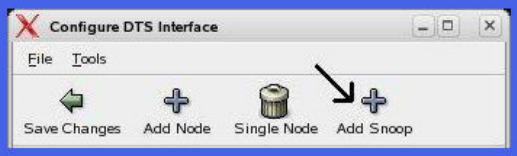
For an explanation of the various errors, see the error page.

Home
Starting the Program
Loading Existing Configurations
Saving Configurations
Changing Setup Fields
Configure Interfaces
Adding a Node
Adding a Snoop Node
Deleting Single Nodes
Deleting All Nodes
Saving/Discarding Changes
Errors
Quitting the Program

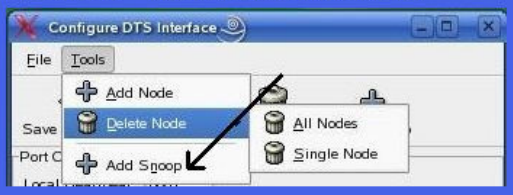
Adding a Snoop Node

This section details how to add a Snoop node. Note: this option is only available on the DTS Interface.

There are two ways to add a snoop node to your interface.
1) Press the Add Snoop button on the tool bar



2) Select Tools -> Add Snoop from the menu



You will be displayed an 'Add Snoop' dialog:

In the Node entry, type the Node Id of the node you wish to add. If you wish to use the default IP Address value for that node, simply press the enter key and the program will automatically fill in the Local IP Address field. You are able to change this value as long as it is valid. Press the OK button. Note: no network card needs to be specified since a snoop node is configured on both cards.

If you enter an invalid value in any of the fields, an error message will appear informing you of the mistake. By acknowledging the error you are able to change the value and press the OK button again.

For an explanation of the various errors, see the error page.

Home

Starting the Program

Loading Existing Configurations

Saving Configurations

Changing Setup Fields

Configure Interfaces

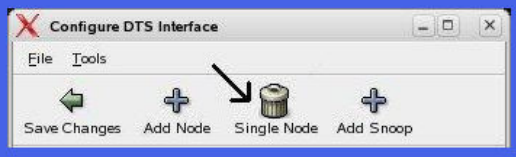
- Adding a Node
- Adding a Snoop Node
- **Deleting Single Nodes**
- Deleting All Nodes
- Saving/Discarding Changes
- Errors

Quitting the Program

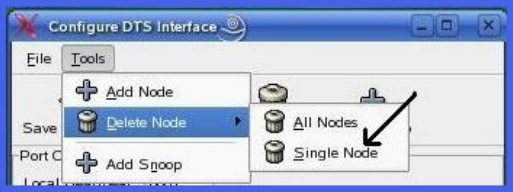
Deleting Single Nodes

This section details how to delete a single node of your choice. Since the principle is the same for every interface, this User Guide will step you through deleting a single DTS node.

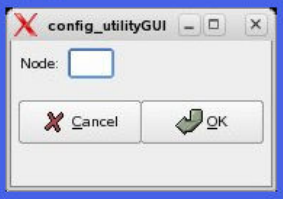
There are two ways to delete a single node from your interface.
1) Press the Single Node button on the tool bar



2) Select Tools -> Delete -> Single Node from the menu



You will be displayed a 'Delete Node' dialog:



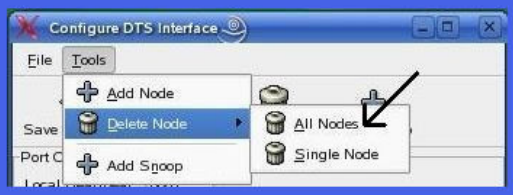
In the Node entry, type the Node Id of the node you wish to delete and press the OK button. As long as the node exists, it will be deleted. If the node doesn't exist, you will be displayed a message informing you of this and you will be prompted to enter a new node.

Home
Starting the Program
Loading Existing Configurations
Saving Configurations
Changing Setup Fields
Configure Interfaces
Adding a Node
Adding a Snoop Node
Deleting Single Nodes
Deleting All Nodes
Saving/Discarding Changes
Errors
Quitting the Program

Deleting All Nodes

This section details how to delete all nodes currently configured on the interface. Since the principle is the same for every interface, this User Guide will step you through deleting a single DTS node. Note: When deleting all in the DTS interface, all Snoop nodes will also be deleted.

To delete all nodes, select File -> Delete -> Delete All



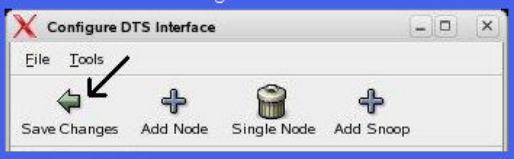
You will be displayed an information message warning you that this will delete all nodes on the interface and will ask you for confirmation. By pressing the OK button, all nodes will be deleted. If you press the Cancel button, no nodes will be deleted.

Home
Starting the Program
Loading Existing Configurations
Saving Configurations
Changing Setup Fields
Configure Interfaces
Adding a Node
Adding a Snoop Node
Deleting Single Nodes
Deleting All Nodes
Saving/Discarding Changes
Errors
Quitting the Program

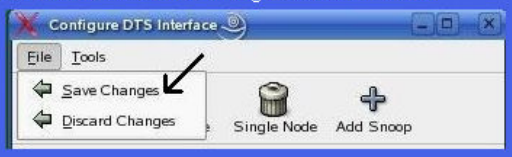
Saving/Discarding Changes

The Configure Interface window allows you to save the changes you have made or discard the changes.

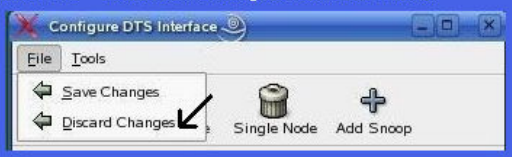
If you chose to save the changes, the main window will be updated so that the new nodes are displayed in the configured nodes table and any nodes you deleted will be removed. There are two ways to save the changes:
1) Press the Save Changes button on the tool bar



2) Select File -> Save Changes from the menu



If you chose to discard the changes, the main window will not be updated and will continue to show the nodes existing before you opened the Configure Interface window. To discard the changes, select File -> Discard Changes from the menu



Home

Starting the Program

Loading Existing Configurations

Saving Configurations

Changing Setup Fields

Configure Interfaces

- Adding a Node
- Adding a Snoop Node
- Deleting Single Nodes
- Deleting All Nodes
- Saving/Discarding Changes
- **Errors**

Quitting the Program

Errors

When configuring nodes on interfaces, many validation checks are carried out. If you do something wrong or a validation isn't met, you will be displayed an error message. The following are some typical errors and an explanation of how to solve the problem.

Adding Nodes

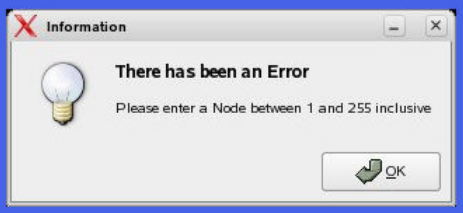
You have forgotten to select a network card to configure your node on. Press the OK button and in the Network Card combo box, select either 0 or 1 depending on whether you want the node to be configured on card 0 or card 1 respectively.

This can also occur for the Remote IP Address

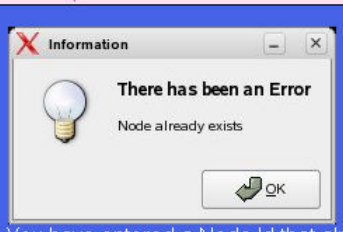
You have entered an invalid IP Address - most probably 255.255.255.255 or 0.0.0.0. Press the OK button and change the IP Address.

This can also occur for the Remote IP Address

You haven't entered the IP Address in the correct format. You must enter four numbers in the range 1 -> 255 seperated with a full stop. Press the OK button and check your IP Address.



You have either forgotten to enter a Node Id or you have entered a number out of range. Press OK and check that you have a Node Id in the range 1 -> 255 inclusive.

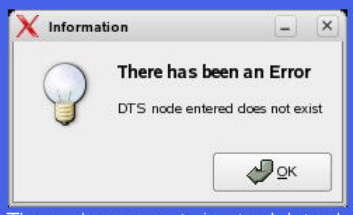


You have entered a Node Id that already exists. Press the OK button and enter a new Node Id. Don't forget to press enter so that the IP Addresses are also changed.

This can also occur for the Remote IP Address

You have entered an IP Address that already exists. No two nodes on the same interface can have the same IP Address (Local or Remote). Press the OK button and check your IP Addresses.

Deleting Nodes



The node you are trying to delete doesn't exist on the interface you are currently configuring. Press the OK button and check the Node Id that you wish to delete.

Home

Starting the Program

Loading Existing Configurations

Saving Configurations

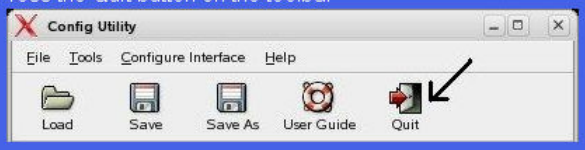
Changing Setup Fields

Configure Interfaces

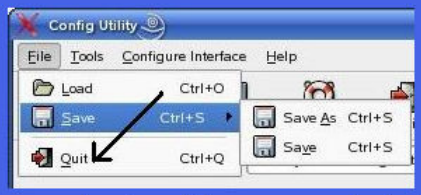
Quitting the Program

Quitting the Program

You can quit the config utility in two ways:
1) Press the Quit button on the toolbar



2) Select File -> Quit



When you chose to quit the program, a check will be made to see if you made any changes that haven't been saved. If this is the case, you will be displayed a message warning you that you haven't saved the configuration and asking you if you wish to quit. You can select OK or Cancel.

If you select Cancel, the program remains as it is and you are able to save the configuration how you wish. If you select OK, the program will continue to quit and you will lose your changes.

Once the program continues to quit, an information message will be displayed asking you to reboot your computer. This is so that the physical IP Addresses you have configured will be set up. This is an essential step if you wish to run SimEng using the nodes you just configured.

Appendix R: GUI Design Research

The following is a summary of the General Principles of User Interface Design, as specified by [9].

Aesthetically Pleasing

Visual appeal makes a system accessible and inviting to the user. The following 'rules' will help to accomplish this:

- The interface must provide visual appeal to the user
- The interface should provide a meaningful contrast between the different elements on the screen
- Groupings should be used
- The elements and groups on the screen should be well aligned
- The interface should provide a 3D representation when possible
- Colour and graphics should be used simply and effectively

Clarity

The information on the interface should be clear and simple. The appearance should also be clear and not too confusing to the user. The appearance of the interface will be reflected in the user themselves the more complex it is, the harder the user will find the software to use. The following rules should be followed:

- Visual elements should be used

- Functions should be included
- Metaphors can be used but kept simple
- Words and text are essential but shouldn't overwhelm the user

Compatibility

The design of the interface should be appropriate and compatible with the needs of the user. The key to good design is to understand the users needs and take on the users point of view. Know the user is the most important principle in interface design.

The structure and flow of the tasks the software provides should enable easy transition from one to the next. It is a bad idea to design the interface in such a way that the user has to navigate between many screens to do the most common task.

You should try to take into account the current software that the client is using and try to incorporate as much as possible into the new interface. This will prevent the user having to learn too much and stop the user getting too confused.

- Ensure the interface is compatible with the user
- Ensure the interface is compatible with the task and the job
- Ensure the interface is compatible with any existing product there may be

Comprehensibility

The steps to completing a task should be obvious. It is not good practice to provide long explanations that must be digested by the user as this will cause confusion and stress.

A user should know the following:

- What to look at
- What to do
- When to do it
- Where to do it
- Why to do it
- How to do it

The flow of actions, responses, visual presentations and information should be in a sensible order that is easy to recollect and place in context.

Configurability

Providing the user with a sense of control will produce higher user satisfaction. If a user can personalise and customise the product, their sense of control and active role in understanding are maximised. For those users that do not want to customise the interface or those that do not have time, a good default appearance is necessary.

Consistency

This is one of the biggest rules in designing a good user interface. Consistency can reduce requirements for human learning by allowing a skill once learned to be used again for various tasks. Excess learning requirements become a barrier to users achieving and maintaining high performance and can ultimately influence user acceptance of the system.

- A system should look, act and operate the same throughout. Similar componenets should have a similar look, have similar uses and operate similarly
- The same action should always provide the same result
- The function of elements should not change throughout the program
- The position of standard buttons/elements should not change

Consistency is achieved by applying design standards or guidelines to the interface.

Control

A user does not want to feel like the computer is controlling them. Instead, they want to be in control of the computer. This prevents the user getting frustrated or feeling demoralised.
To provide control in an interface, it should be simple, predictable, consistent, flexible, customisable and passive. The following should be avoided to prevent the user feeling the computer is in control: the system becoming unavailable, a long delay in the system responding, surprising system actions, tedious and long procedures that can not be stopped and the inability to achieve the desired results.

- Actions should result from explicit user requests

- Actions should be performed quickly
- It should be possible to cancel an action or interrupt it
- The user shouldn't be interrupted for errors
- The context of the interface should be designed from the users perspective
- Goals should be possible to achieve by the user. They should be flexible and compatible with the user
- Avoid modes - they constrain the actions available to the user

Directness

The users work loads should be minimised as much as possible. This can be done by adhering to the following guidelines:

- The interface should provide direct ways to accomplish tasks
- Available alternatives should be visible
- The effect of actions on objects should be visible

Efficiency

You should try to keep the users attention captured by relevant elements on the screen. You should try to minimise the number of transitions between input devices such as the keyboard and mouse. Always try to anticipate the users wants and needs. Always present any information the user may need / do not design the interface so that the user has to search to find what they want to know.

- Minimise eye and hand movements of the user
- Transitions between system controls should flow freely and easily
- The navigation path between actions should be as short as possible
- The user's eye movement through a screen should be obvious and sequential

Familiarity

Try to design the interface by building on the users existing knowledge. Include concepts, terminology, workflows and spatial arrangements that are already familiar to the user.

- Use familiar concepts and use a language familiar to the user
- Keep the interface natural
- Use real world metaphors

Flexibility

The system should be able to respond to individual differences in people. Different paths should be provided to accomplish the same result, providing a different approach for the different types of users. Flexibility can also be produced by providing customisation. Flexibility also increases the users control. Do not make the system too flexible or it will confuse new users.

Forgiveness

A system that forgives its user for common errors will keep the user out of trouble. It is known that people learn by trial and error / many people will not use the 'help' of a system until they have realised they can not work it out for themselves. If a system is over sensitive to errors and presents many messages to the user, it will overwhelm the user and will discourage the user from exploring the system further.

- The system should tolerate and forgive common and unavoidable user errors
- Try to prevent errors from occuring as much as possible
- Protect the system against possible catastrophic errors
- Provide constructive messages when an error occurs

Predictability

The user should be able to use their previous knowledge and experience to predict the movement through a system. All actions should provide a result the user expects. Predictability reduces mistakes and enables tasks to be completed more quickly. Predictability is greatly enhanced by design consistency

- The interface should provide distinct and recognisable screen elements
- It should provide clues to the result of an action to be performed

Recovery

An undo command is essential for nearly all systems. Safe in the knowledge that an action can be undone, new users will be happier using the system. Recovery should be obvious, automatic and easy

to perform. Easy recovery greatly facilitates learning by trial or error and exploration. If an action is not reversible, it should be ensured that performing the action does not produce critical consequences.

- The system should allow an action or command to be cancelled
- It should allow an action or command to be reversed
- Ensure the user can't lose their work through making an error
- Also ensure no work is lost through hardware or software issues

Responsiveness

Response to the user instils confidence. Never leave the screen blank for a moment as the user will think the system has crashed. If an action is going to take a long length of time, it is a good idea to provide a progress bar, or some kind of animation so that the user knows the system is working.

- The system should respond rapidly to the user's request
- You should try to provide visual, written or audible conformation when a user performs an action

Simplicity

The opposite of complexity. Complexity overwhelms the user and can confuse them. A system should not be too simple though. This could make the system tedious to use or not accomplish much. It is better to provide less functionality that will get effective use, than to provide too much functionality. Ultimately, your aim is to produce a complex system with a simple interface. There are several ways to minimise complexity, as follows:

- Ensure the interface is as simple as possible
- Use progressive disclosure - hide things until they are needed
- Present common and necessary functions first
- Prominently feature important functions
- Hide more sophisticated and less used functions
- Provide defaults where possible
- Make common actions simple by making uncommon actions harder

- Provide consistency and uniformity

Transparency

The users thoughts need to be focused on their task at hand. They do not need to know how the system works, just that it does.

- Don't worry the user with the mechanics behind the system
- Workings and reminders of workings inside the computer should be invisible to the user

Trade-Offs

The design guidelines associated with the interface will often produce conflictions. The designer must look at all requirements when producing the final interface. The users requirements must take precedence over any technical requirements.
The following is a summary of 'bloopers' to avoid, as specified by [10].

Dynamic Menus

- Don't have menus that change depending on what the user is doing. This will just confuse the user. They may not realise why one menu item is available at one time and not another time and this will frustrate them
- It is a much better idea to have all the menu items on view at all times and disable any items that aren't available at the time
- It may also be an idea to have new menus appear when they are available to use. This is so that you never have items in the menu that can't be used but a whole new menu appears when the user enters a part of the system that has extra options
- An example is in Microsoft Word, there are many toolbars that appear when the user decides to do something. The picture toolbar appears when a picture is inserted. For the experienced user, there is an option to have this toolbar on show at all times, but by then they shouldn't get confused by it

Duplicate Menu Items

- The main reason that duplicate menu items occur is when the designer is unsure of what menu the option should go under

- Although there is a slight advantage of having the same option in two different places; the user has more chance of finding that option, there is also a disadvantage. If a user sees the same menu item in two different places, it is likely that they will think both options do different things and so this will confuse them as to which option is the one they want
- It would be even more stupid to have the same menu item in two different places with different names. This would totally confuse the user and would be pointless
- Another problem with multiple menu options is that it misleads the user into believing that the system is more complex than it really is
- The only time there should be duplication of options is between the menu, toolbars and right click mouse options
- It may be a good idea to initially have duplicates so that you can test which is the best place for each option but they should be removed before shipping
- Any menu items that are in most applications should remain in the same place and order to avoid confusion
- The left most menu item in a window should be file and in the main window, the last option within file should be quit. Any window that is not the main window should follow the same idea but instead of quit they should have either ‘close’ or ‘back’ so that the user knows that it will not exit the whole program

Hidden Functions

- There should be no functions that are only available by key commands or other means that the user can not see
- Most users learn how to use software by trial and error. These hidden functions would only be learnt by reading the user guide or by hearing from someone else
- For example, if it is possible to delete an item by pressing ‘del’ or by using ‘Ctrl’ + ‘X’, there should also be an option (in the edit menu) called ‘Delete’ that does the same thing
- The main reason designers do this is because it is what they are used to, but it is known that the majority of users prefer graphical interaction to a key command

- Another reason for it is lack of space. This is where the trade-offs must be looked at (see above) to decide which functions are actually needed
- third reason for hidden functionality is that it is believed to be quicker than using menus. This is true but only if the user knows they are there. It would be better to cover both options and provide a menu item and a shortcut option

No keyboard equivalents

- There are some users that would prefer not to use a mouse. This is for many different reasons
- It reduces time having to switch between mouse and keyboard
- Some users are used to the older software, before GUI and that is what they are used to
- Some users are not able to use a mouse for different reasons
- Some users do not even have a mouse
- Finally, there are the users that can not see. Using a mouse would be impossible and so the blind need to use keyboard commands
- This reduces the usability for a wide range of users and where possible, keyboard commands should be included
- There are two different types of keyboard equivalents; access keys and shortcut keys
- All menus and menu items should have an access key. These are denoted by underlining a character and are accessed via this letter and another key
- The access keys must be unique throughout the system
- It is better to use a letter near the beginning of the word to facilitate remembering
- Shortcuts can be assigned to any operation that the designer wishes. They are normally attached to common functions within the system and normally compromise of the Ctrl key and another letter
- The letter that is used must be unique throughout the system and it makes it easier for the user if the letter is the first letter of the function

Confusing primary windows with dialog boxes

- There are three main errors that are made when designing a GUI
- The main window is designed as a dialog box. The main window must have a menu. This lets the user know it is the main window
- Hybrid windows. Do not design a window that has both a menu bar and the dialog buttons at the bottom of the screen
- Dialog boxes that are minimisable. A dialog box should not be allowed to be minimised. This will give the appearance of a window and will confuse the user
- A window should only be used when the options and data displayed are going to be on view for a long period of time

Things to remember about primary windows:

- They can be minimised to a desktop item or taskbar button
- It remains displayed unless explicitly closed or minimised
- It is likely to remain displayed for an extended time (to do multiple operations or to keep program data in view)
- It is never modal; that is, it does not block input to other windows, whether in this application or another
- It has a menubar containing the application's commands, categorised
- It has a help menu as the rightmost menu on the menubar
- It optionally has a toolbar containing buttons representing a subset of the commands from the menubar menus - either those that are frequently used or ones the user has placed there
- It has a full set of window decorations, including minimise, maximise and resize
- It has a 'close' command or an 'exit' command at the bottom leftmost menu item
- It has no window control buttons along the bottom or right edge

Things to remember about a dialog box:

- It is never minimisable to a desktop item or taskbar button
- It disappears when it's parent window is closed or minimised and reappears when it's parent window is un minimised
- It is usually displayed only temporarily, for example, to set arguments for a pending command or to view or alter properties of an object
- It can be modal, although this should be fairly rare
- It is usually temporary; that is, it is displayed only to support a specific operation and is dismissed thereafter
- It it often not resizeable, although it can be if it contains a scrolling list or other component with a resizable viewport
- It has a row of window control buttons along the bottom, or, less commonly, along the right edge
- It has a close or cancel button as one of the action buttons
- It has no menu bar or button toolbar

There are many more bloopers to avoid when designing a GUI but these seem to be the ones that will be of most use to my project.

Appendix S: Creating a DTD

Creating a DTD:

1. Create the declarations
    - Each declaration adds a new element, set of attributes, entity or notation to the grammar you are describing
    - The order of the declarations is important in two situations. Firstly, if there are redundant entity declarations, the first one that appears takes precedence and all others are ignored. Secondly, if parameter entities are used in declarations, they must be declared before used as references
    - Whitespace is generally ignored in DTDs, the only place you should not put it is in the string of characters identifying the declaration type
2. Keep declarations seperated into sections by their purpose – this helps you navigate in the file
3. Pad the declarations with lots of whitespace. This makes the document more understandable
4. Indent lines inside declarations to make the delimiters more clear
5. Between logical divisions, use extra space and perhaps a comment with a row of darker characters to add separation. This also makes it easier to navigate through the document
6. Use comments as much as possible. Put a comment at the top of the file explaining the purpose of the DTD, stating the version number and contact information

7. Label each section and subsection
8. Put a comment anywhere it may help to explain decisions or use of the DTD
9. Add new comments as the DTD is updated
10. Keep track of your updates by adding a version number to the DTD. This number should be updated every time a change is made to the document (not for every single change but every time you update the document)
11. It is conventional to update the major number when larger changes are made and the minor number when smaller changes are made
12. Document the changes between versions
13. Chose names that make sense - they should closely match the logical purpose of the element
14. Try to have a tree like structure that resembles a wide, bushy shrub
15. If it becomes too deep, the markup begins to overwhelm the content and it becomes harder to edit the document
16. If it is too shallow, the content is probably too sparse
17. Know when to use elements over attributes
    - An element holds content that is part of the document
    - An attribute modifies the behaviour of an element
18. Find a balance between using general elements with attributes to specify purpose and creating an element for every single contingency

Appendix T: Company Evaluation

Quoted from the Technical Authority of SAINTT:

> The tool builds and runs successfully on the SUSE distribution of linux. The tools look and feel is as myself and Jen discussed before the start of the project. It also matches the designs that Jen showed me earlier in the project lifecycle.
> As requested the main window consists of the information about setup files and the ability to change the ones that the user is allowed to change. The main window also contains a summary of the nodes currently configured. All of these values are set to sensible defaults.
> Other configurations can be loaded. I loaded a sample configuration (different from the default) and this worked fine.
> The configuration of nodes (sets of IP sockets) is done from a second window. This window can be created from the main menu, as I'd expect. This is a separate window, which follows the general linux HCI style.
> Port numbers are constant across all nodes, for a given interface type, as I'd expected. The port numbers are given defaults, allowing

the user not to enter numbers if they don't need to change them. On entering a node Id, sensible defaults are set for the local and remote IP addresses. The IP addresses are properly validated, which is necessary for inexperienced users, who would be prone to entering invalid values.

I find the application is intuitive to use, which my main wish for it. The extensive use of default values, and validation allows inexperienced users to setup basic configurations, while allow others to setup more advanced, non-standard configurations.

In terms of areas of improvement, the application could be ported to libglade, and accelerator keys (i.e. keyboard shortcuts) could be added. More types of interface could be added, though it was always intended that only a subset would be implemented.

The tool correctly sets up the IP Addresses on reboot for both the eth and znb, cards 0 and 1 as expected and when using the tool on two different computers to set them up to interact with each other, everything runs as it should, showing that the tool is performing correctly and as expected.

Appendix U: Details of Additional Functionality

Add New Interface Additional Fnctionality

In order to generate the correct GUI and code, a lot of information will be required from the user. Just as a start the following would be needed:

Name of Interface: _____

Min number of interfaces required: _____

Max number of interfaces required: _____

Number of Ports: _____

If > 0 →

Port1 Name: _____

⋮

PortN Name: _____

Port1 Range: _____

⋮

PortN Range: _____

(Number of ports specified)

Are any of the Ports related to other Ports? ___

If Yes →

Port number (new interface): _____

Linked to interface: _____ Drop down with existing interfaces

Port number (other interface): _____ Drop down ports

Relationship: _____ Same Value / Opposite Value / Other

If Other →

Details: _____ Complex

Local IP Address Format: _____

Remote IP Address? ___

If Yes →

Remote IP Address Format: _____

Any additional requirements? ___

If Yes →

Window: _____ Add Node / Delete Node / Main / New

Requirement: _____ If NOT 'New'

If New →

Name: _____

Details: _____ Complex – we don't know what will be filled in here

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